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CONTENTS

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SOME APPLICATIONS OF PALEONTOLOGY[1]

PERHAPS the most remarkable feature in Dr. Joseph Leidy's mental make-up was the immense variety of his scientific interests and achievements. I would use the word *versatility* to describe him, were it not that that term usually implies a certain degree of superficiality, which was utterly foreign to Leidy's mind, for thoroughness and minute accuracy were characteristic of him.

Last year, the centenary of Dr. Leidy's birth was celebrated in the Academy of Natural Sciences in Philadelphia, at which each one of a number of speakers dealt with his own specialty and with Leidy's activity in that particular branch of science. I think that every one who attended that celebration was astonished to hear that fields which they had never associated with Leidy's name had been successfully cultivated by him. For instance, I imagine that very few people knew anything of Leidy's work in botany, or in geology, matters which lie outside of the range of work with which his name is usually associated, even by those to whom he was more than a name in America's honor-roll. Among all those strikingly varied fields which he cultivated so successfully, there is none, I think, which has so contributed to his fame throughout the world as that of paleontology, especially of the vertebrates. In this work Leidy was a pioneer. There had been some work done by such men as Wistar and Harlan in Philadelphia, Mitchill and DeKay in New York; but these men had dealt with such fossil remains as are found in the Eastern States, occurring near the surface of the ground and of very late geological date, including mastodons, horses and ground sloths. It was once thought, both in this country and in Europe, that North America contained no fossil vertebrates of any particular interest or importance, and that, in this respect, we should have to admit inferiority to South America and to the Old World. The first breach in this tradition was made by Leidy, when he began to receive through Dr. Hiram Prout, of St. Louis, fragmentary fossils brought in by the fur-traders from that marvellous and inexhaustible field of discovery, the White River Bad Lands of what was then Nebraska Territory.

[1] No. IV of the Leidy Memorial Lecture Series. Delivered at the University of Pennsylvania.

The White Earth River, to give its full title, is a muddy stream which flows into the Missouri, its course nearly parallel with that of the Cheyenne. Between these two rivers, and on both sides of them, especially south of White River, is the vast area of bad lands, 150,000 square miles or more in extent; and it was with the fossils collected from this region that Leidy's most important contributions to paleontology were made. This is not to overlook the value of his investigations among Eocene mammals and reptiles and Cretaceous reptiles of the Far West, but merely to emphasize the greater importance of his work on the White River fauna. Aside from the great number of short papers published in the *Proceedings* of the Philadelphia Academy of Natural Sciences, the two great monographs of 1853 and 1869 are his monuments, and they form the foundation upon which the great edifice of subsequent work has been erected.

Leidy himself did not collect from the Western fossil grounds; unless I am mistaken, his first visit to those regions was made in 1877, when I met him at Fort Bridger at the house of his friend Dr. Carter, who had sent many Eocene mammals to him. It must be emphasizeed that the art of collecting vertebrate fossils was quite undeveloped in the United States, and that the material sent to Leidy was nearly always made up of such bones as had been weathered out of the soft bad land rocks and were picked up, in a more or less fragmentary condition, so that only skulls and jaws and a few occasional limb bones were included. He had no skeletons to deal with, nor even a single well-preserved foot, only a few good skulls and a great quantity of fragments. Another reason why collections from the White River beds were so hastily and unskilfully made was that till quite late in the century the region was unsafe for white men. My first expedition to the White River bad lands was in 1882, and the U. S. Indian agent at the Pine Ridge Agency warned me that my enterprise was a dangerous one, and advised that my camps should be guarded day and night. So late as the winter of 1890-91, there were fierce battles with great loss of life between the Sioux tribe and the U. S. Army; since that time the region has been entirely safe for the collector.

One of Leidy's most serviceable friends was Dr. F. V. Hayden, long the director of the U. S. Geographical and Geological Survey of the Territories, who from 1856 till 1880 was constantly engaged in surveying and collecting in what were then the "Territories," and was thus able to send much valuable material to Leidy. Even such fossils as were assigned to the collections of the Smithsonian (there was no U. S. National Museum in those days) were first determined and described by Leidy. Hayden's collections were, in large degree, the basis of Leidy's splendid quarto monographs of 1853 and 1869. Hayden enjoyed among the Sioux the enviable reputation of being mad, and therefore his person was under divine protection and inviolable; this enabled him to go about freely, breaking rocks and picking up old bones, where other white men would not have dared to show themselves.

Before proceeding farther, it will be useful to stop for a moment and explain the oft-used phrase "bad lands." The term is a partial translation of the expression used by the French Canadian *voyageurs*, "mauvaises terres à traverser," bad lands to cross. Our abbreviated form of the term gives a false impression of utterly barren and useless grounds, whereas, in many regions, the flats and bottoms are covered with grass and form an excellent winter range for cattle. The term "bad lands" applies to the gullied and cut-up shapes of the valleys and hillsides, which are worn and gashed by the rain and melting snows. Wherever soft and easily weathered rocks are widely exposed in an arid or semi-arid climate, then bad land topography is developed, and many hundreds of thousands of square miles of these peculiar regions, often presenting views of the wildest and most unearthly scenery, extend through the Far West from Alberta to Mexico, and ranging in geological time from the Cretaceous to the Miocene. Very often, but not always, the bad lands are a paradise for the collector of fossils, because of the immense areas which are exposed to view, and if the beds, so worn and gashed, are richly fossiliferous, then great numbers of fine specimens are weathered out of the enclosing rock. Of course, if the beds were originally barren, weathering will not supply them with fossils.

What I especially wish to talk about this evening, the main subject to this lecture, is a consideration of the reasons why Dr. Leidy should have been interested in these things. Why should any one care about a lot of old bones, and why do the universities and museums spend vast sums to obtain them and prepare them for exhibition? Could anything seem more absurd than for the American Museum, in New York, to equip and maintain costly expeditions to India, to the Gobi Desert of Mongolia, to South America, merely to gather more or less petrified bones? Not only bones, but shells and tests, insects, corals and plant-impressions, are all fish for the paleontologist's net and to the uninitiated it must seem a singularly futile type of child's play. It was Darwin's great book, published in 1859, that gave a new impetus to the study of these things; before that time it was believed among geologists that the earth's history consisted of a succession of periods of calm and quiet rock-formation, interrupted at intervals by great cataclysms, which destroyed all the life of the earth.

When tranquillity was restored, a new creation was made to replace the old. This was the catastrophic theory of Cuvier, which, so far as the rocks were concerned, was gradually replaced by Sir Charles Lyell's theory of uniformity, according to which the earth's history was an uninterrupted sequence, but Lyell did not venture to suggest the evolutionary conception of plants and animals and their gradual development by natural agents.

From the beginning of the Nineteenth Century, geologists had made most careful studies of the fossil invertebrates, which were (and are still) an indispensable means in arranging the rocks of the earth's crust in chronological order. Fossil vertebrates, on the other hand, were of much less use for such purposes, because of their comparative scarcity, and therefore but few men took any interest in them. When new ones were found, they received names, were catalogued in their proper systematic order, put into glass cases, and ignored. According to the dominant theory of special creation, which taught that every species of animal and plant was unchangeable, save within very narrow limits, and owed its existence to a creative fiat, vertebrate paleontology could be little more than a descriptive catalogue of the animals which had successively appeared on the earth. Darwin's book, which immediately divided civilized mankind into two opposite and warring camps, completely changed the status of paleontology. Every one recognized that the fossils offered one of the best means of putting this newfangled theory of evolution to a crucial test. Since the fossils were the actual remains of the animals that once had lived on the earth, and since the rocks gave us their order of succession in time, then the fossils ought to make manifest whether they formed genetic series, connected by a real blood-relationship of ancestor and descendant, or whether they were due to separate acts of creation, related only ideally in a common creative plan. None of the biological sciences was so completely transformed and rejuvenated by Darwin's work as was the paleontology of the vertebrates, which thus received an entirely new content and significance, causing it to thrive and flourish mightily. I may remark here, incidentally, that some of the strongest and most convincing proofs of Darwin's views have been supplied by paleontology.

It is time for us to have done with this preliminary discussion and turn to a consideration of the topics announced in the title of this lecture, *viz.*, some of the applications of paleontology. Nature is one and indivisible, and the important discoveries made in one branch of science are sure to effect more or less radical changes in other branches. When M. and Mme. Curie announced the discovery of radium and the amazing phenomena of radio-activity, no one could have foreseen that these newly discovered phenomena were to affect profoundly the sciences of astronomy and geology. Such has been their effect, nevertheless. The discoveries of paleontology have modified biology, geology, geography, and even, strange to say, the seemingly remote science of astronomy.

The first and most obvious application of the modern paleontology, which was so fertilized and stimulated by Darwin's writings, was to explain the facts of zoology and botany; but another, and very much older, application was as a means of arranging the earth's history chronologically and correlating the histories of the various continents and seas into a single consistent and harmonious earth-history. This use of fossils does not depend upon any theory of the origin and succession of living forms. Familiarly and universally employed for sixty years under the prevailing belief in special creation, it still continues to be employed as widely now that all the world has accepted a belief in evolution. I refer to the use of fossils as a means of arranging the rocks in chronological order. This great and fundamental discovery was due to William Smith, an English engineer, though Cuvier and Brongniart made the same discovery in France almost at the same time.

Last summer I had the good fortune to be in Bath, and was invited to take part in the ceremony of unveiling a tablet to the memory of William Smith. This tablet was placed on the outer wall of a house in which Smith, in 1799, had dictated to a friend "the order of the strata." That was the beginning of historical geology. Smith had observed that the strata, or beds of water-laid rock, were arranged in a certain order, one over the other; further, he noted that each group of beds was characterized by a particular assemblage of fossils, such as occurred in no other beds, and that, from the succession of beds the succession of fossils might be made out. Having determined the succession of fossils, it was possible to apply it in new regions, and it was found to apply in other parts of England, in France and in Germany, and gradually its application became world-wide. It can be employed in America, Africa, Australia, or any other part of the earth's surface.

The principle is extremely simple, and is widely made use of in historical and archeological inquiries of all sorts. For example, the student of handwriting has learned from a careful study of *dated* manuscripts that the handwriting of the mediaeval copyists underwent changes in a certain definite order; having learned the order of change, it is possible to use that order to place *undated* documents from their handwriting alone. One needs but little experience to distinguish writing of the eighteenth century from that

of the nineteenth or the seventeenth, and expert paleographers can determine the date of a document within a decade of its writing. Though simple and obvious, this principle has been persistently misunderstood, and from time to time it has been attacked. Even so great a man as Herbert Spencer could not see that it did not involve reasoning in a circle, and declared that it was unscientific. But such an inference is due to a failure to grasp the significance of the method.

The progress of life from the lower and simpler to the higher and more complex upon which Smith's system is founded is substantially the same everywhere. This is because the fossils which are employed for chronological purposes are chiefly those of marine animals; and as all parts of the sea are in communication with one another, the only barriers which prevent the universal spread of marine organisms are those due to temperature, so that the inhabitants of warm seas are very different from those of cold waters. In former ages of the earth, however, when a more uniform temperature prevailed and climatic zones were but faintly indicated, the inhabitants of the different oceans were much more nearly alike than they are now.

The paleontology which was rejuvenated, almost re-created, by Darwin proved to be an indispensable means of explaining the anomalous distribution of land animals and plants in the various continents. Before Darwin's day, much interest was taken in the geographical distribution of animals, but merely as so many statistical facts, for which no explanation could be found. As Darwin tells us in his autobiographical sketch, it was the facts of paleontology and of the geographical distribution of animals, which he observed in South America, that first led him to question the truth of the then almost universally accepted dogma of special creation. He felt assured that if the theory of evolution were to be accepted as true, it must be able to explain distribution. The present order of things on the earth, geographical, climatic, and biological, is, according to the evolutionary theory, the necessary outcome of an unimaginable series of changes throughout hundreds of millions of years; and, if that theory is to be accepted as true, it must be able to offer a reasonable explanation of this present order. If the geographical arrangement of animals in existing lands is not due to special creative fiat, but to natural causes, and is the inevitable result of the long sequence of past changes, then paleontology should be able to offer an explanation of the anomalies and paradoxes in that arrangement.

For example, the camel family is divided into two sub-families, the true camels of the Old World, native to Asia, and the llamas, guanacos, etc., of South America. This seems to be a very anomalous kind of distribution, to have the two parts of the same family separated as far as the size of the globe will permit; yet the history of the family, as recorded by the fossils, offers a simple explanation. The group originated in North America and for long ages was confined to that continent; at first, there was but a single series without distinction of sub-families, and this series shows in each successive division of geological time a continuous advance and development. Finally, the series gives off two branches; the true camels, which passed into Asia by way of the raised bottom of Bering Sea; the other, the llamas, into South America. For a time both sub-families were present together in North America, and were completely wiped out by the great Pleistocene extinctions. It is their extinction in North America which has brought about the wide separation of the surviving species.

This explanation is typical of a great many cases of what is called "discontinuous distribution;" whenever the history is known, it is found that the group in question once occupied the intervening area and then became extinct in that area. Not that all cases can be explained, by any means; in such cases the history of the animal group has not yet been recovered and deciphered, perhaps never can be. But it may be stated as a rule, without known exception, that whenever the history and development of a group has been made clear, its modern distribution is thereby explained. This could not be true were each species an immutable entity, separately created.

The present distribution of the tapirs exactly parallels that of the camels and llamas; they are found only in southern Asia and in Central and South America. Throughout nearly the whole of the Tertiary period, these curious creatures were distributed all around the northern hemisphere; in this country fossils of them have been collected from Los Angeles to Port Kennedy on the Schuylkill and southeast to Florida. Then, for some unknown reason, they disappeared from all lands save those in which they still occur. Like the camels, the tapirs probably originated in North America; at all events, they have been found here in rocks more ancient than in any other known region.

As a last illustration of the manner in which paleontology explains distribution, we may take the case of the Proboscidea (elephants and their close relatives, the mastodons). The mastodons are extinct, and the present occurrence of elephants would seem to require no particular explanation, for they are found only in the warmer parts of Asia and Africa, between which there is land connection now. In the epoch immediately preceding the present, Proboscidea were found in all the continents, perhaps even including

Australia; only elephants in the Old World, from Great Britain to South Africa and eastward to China and Siberia. In North America elephants and mastodons ranged together, but only the mastodons extended into South America. In the late Tertiary (Pliocene epoch) the facts were the same, except that the mastodons were also present in all lands of the Old World. In the middle Tertiary (Miocene) only mastodons were in existence, the true elephants having been subsequently derived from them. The mastodons appeared in North America and Europe almost simultaneously (in the geological sense of that word); but for a long time we were ignorant of their place of origin, for their appearance in the northern regions was entirely unheralded, and nothing was known in the earlier epochs which, by any stretch of the imagination, could be regarded as ancestral to these Miocene mastodons. By a process of elimination that region of origin could be narrowed to the warmer parts of Asia and Africa; and there the desired ancestors were at last found, first in the Oligocene and Eocene of Egypt, carrying the genealogy back to a much earlier time and more remote antecedents than in the northern lands.

Last year, I presented a paper before the American Philosophical Society on "The Isthmus of Panama as the Strategic Point in the Distribution of North and South American Life." In this paper I brought forward evidence to show that in the Cretaceous period the two western continents were joined by continuous land, while in the earlier half of the Tertiary period, they had been divided by a sea which occupied the site of Central America and the Isthmus. This separation brought about complete difference in the North and South American faunas; and the final re-elevation of the land accounted for the many animal groups which are now common to the two continents.

I do not mean to leave with you the impression that all the problems of animal distribution have been solved, for this is far from being the case. Many such problems still await the solution which may never be found. On the other hand, it is a highly significant fact that whenever the fossils enable us to reconstruct the history of a group of plants or animals its distribution, present and past, is thereby explained; and the cases of distribution which we cannot explain are those of which we do not know the history.

A third application of this science, to which Leidy devoted the most fertile years of his life, is that which enables us to follow the past climatic changes which have succeeded one another upon the earth. The climatic history of the earth is one of the most wonderful parts of its marvelous story and has wide astronomical bearings, as well as geological and geographical. That life has existed on the earth without interruption for a billion years or so is now a familiar fact and when it is remembered within what narrow limits of temperature terrestrial life is possible, the constancy of solar radiation throughout that unimaginable lapse of time is all but incredible. Thirty years ago Lord Kelvin's calculations of the age of the sun were very generally accepted and, according to these, the sun could not be more than 20,000,000 years old. The discoveries in the field of radio-activity have indefinitely extended the time involved in the history of the solar system.

While the climatic changes through which the earth has passed have never been so extreme as to exterminate all living things, they have, nevertheless, sufficed to bring about very remarkable results. Throughout much the greater part of the earth's recorded history, its climate has been so mild and nearly uniform that the temperature-zones, so familiar to-day, are scarcely or not at all indicated; and this fact led to the widespread belief among geologists that the glacial ages of the Pleistocene had been altogether exceptional, and due to some transitory cause from which the present amelioration was a slow recovery. Subsequently it was learned that there had been several glacial times recorded in the rocks, the oldest of which antedated the fossiliferous rocks; and there is now reason to believe that these times of refrigeration were rhythmically recurrent, at intervals of approximately 250,000,000 years. The evidence of former glaciations is mostly to be found in the rocks themselves; the fossils, which sometimes give corroborative testimony, are often unavailable, but for the less extreme fluctuations of climate paleontology gives the only evidence which can be trusted. All classes of organisms may give proofs of climatic changes, but the most useful are fossil plants.

The Mesozoic era and the earlier part of the succeeding Tertiary period had climates, not only free from other than local glaciation, but even much milder and more uniform than those of the present day. Greenland, for example, which now can support only dwarf willows and birches, 2 or 3 inches high, then had abundant forests of temperate zone type. Great palms were growing as far north as Idaho and Montana, and large crocodiles accompanied them. In the Jurassic period, the Antarctic continent, the most lifeless and desolate of all existing lands, had plants like those of England. The enormous reptiles which throughout the Mesozoic era inhabited all the continents and oceans, even in the far North, could not have endured the Arctic climate of the present. The gradual refrigeration of the climate, leading to the Glacial epoch, is likewise clearly recorded by the

fossils, also the very curious fact that interglacial climates were milder than those of the present time. The term "interglacial" requires a word of explanation. After Agassiz's conception of a glacial time, when the northern parts of Europe and North A. erica were, like modern Greenland, buried under great sheets of moving ice, had been almost universally accepted, evidence began to appear that the Glacial age had not been single, but multiple; and the proof which has accumulated in many lands has convinced nearly all students of the problem that Pleistocene glaciation consisted of at least four Glacial stages, separated by three Interglacial stages when the climate was warmer than at the present time. On the north shore of Lake Ontario, near Toronto, there is a series of bends, laid down in water, the interglacial nature of which is shown by the two glacier-made boulder beds, between which the sediments deposited in water are contained. The water-laid beds are in two series, of which the lower one has preserved many leaf-impressions, and these plainly indicate a climate considerably warmer than that of present-day Ontario. Other interglacial deposits on the shore of Hudson's Bay and in the Great Plains region contain fossils of plants and animals indicative of a relatively warm climate, milder than the climate of the same localities in recent times.

Similar facts have been observed in Europe, and in few places are the climatic indications more beautifully clear than at Mauer, where the famous jaw of the Heidelberg Man (*Homo heidelbergensis*) was discovered. This lower jaw was found in a sand-pit some forty feet below the surface of the ground; and in the same bed as the human remains, and evidently contemporary with them, were found the bones of many mammals, such as the southern elephant, hippopotamus, etc., which plainly suggest a climate warmer than that which now prevails in Central Europe. Not far above this bed are numerous bones which show the renewed refrigeration which was to lead to another glacial stage, as must be inferred from the bones of the boreal mammals which are there found. The southern animals have all disappeared from the region, and their place is taken by cold-country creatures, such as the mammoth, or woolly Siberian elephant, reindeer, and the like. The climatic inferences to be drawn from these two sets of animals are quite unmistakable, and it is interesting to note how closely the facts in Europe and North America correspond.

The whole process of reconstructing the earth's past history, the arrangement and changing connections of the great land-masses of the various seas, is dependent upon the study of fossils, which give a record of changes in their order of chronological succession. That is where geology has a great advantage over so exact a science as astronomy, for the exactitude of astronomy is confined to the present order of things; and in dealing with historical problems concerning the origin of stars and planetary systems, there is great vagueness and little certainty. For over a hundred years, the Nebular Hypothesis of the great French astronomer, La Place, was accepted by astronomers and geologists with practical unanimity, as explaining the origin and history of the solar system. Now that hypothesis has no standing with astronomers and among the geologists of England and America, the ancient hypothesis is completely abandoned, for it has been conclusively shown that La Place's conceptions are mechanically impossible. Nevertheless, many if not most of the German geologists still adhere to the scheme of La Place, chiefly because they are not convinced of the truth of the hypotheses which have been propounded to take the place of the discredited nebular theory. Astronomers have no such record of the past as the fossils offer to geologists and, in the lack of that record, they can not solve historical problems with confidence.

Needless to say, I hope, this statement is not meant to belittle the astounding achievements of astronomy, which include the highest attainments of the human intellect. Nor would any prudent man be so foolish as to attempt fixing any limit to the progress of astronomical discovery. What methods of investigating and determining the origin and development of the celestial bodies may hereafter be devised, no man can predict. At present, however, astronomy can not deal with these historical problems in an assured way.

To many minds the most interesting and important of the applications of paleontology is the testimony which the fossils give to the theory of Evolution. As we have seen, it was Darwin's book that rejuvenated the study of fossils and gave it an unheard of extension. It was immediately and generally recognized that the most crucial test of Darwin's theories would be, whether it was in harmony with the facts of the geological record, or in hopeless conflict with those facts. Even more exacting and severe was the test of future discovery. It has often happened in the history of science that a theory which satisfactorily explains and coordinates the facts known at the time it is first enunciated, is gradually undermined by the discovery of new facts, which do not harmonize with it, until the exceptions outweigh the rule and the theory collapses.

When Darwin published his great book, he showed in a famous chapter that the facts of paleontology agreed with his theory as well as could be expected in view of the admitted incompleteness and imperfection of the geological record. Since that date, the

geologist has extended his exploring and collecting work to all lands that can be reached and studied. Wonderful series of fossils have been found in western North America, a work of collecting which had just begun in Darwin's day, when no one had any conception of the astonishing museum of long-vanished animal life which is entombed in the rocks of arid and semi-arid America. As we have already learned, one of Dr. Leidy's securest titles to fame is the great work which he did in revealing and reconstructing this record. Likewise, Africa, Asia, and even parts of Europe, have all yielded up treasures of fossils, of which Darwin had no inkling. He himself was one of the first to discover the richly fossiliferous beds of Patagonia, but he had not the smallest conception of what was to be found there sixty years and more after his explorations in South America.

There has thus been a veritable flood of new discoveries which put the evolutionary conception to the severest possible test. The result has been that that conception has been supported and strengthened in a wonderful way, and is far stronger and more universally accepted than it was sixty years ago. No competent person would maintain that all problems have been solved and all difficulties removed; far from it, but those difficulties are plainly due to lack of information. The record of the development of living things which is contained in the rocks is like a book from which many pages, even whole chapters, have been torn out. On the other hand, many chapters have been preserved, of which the fullness and precision make a perfectly unambiguous and most eloquent support of the theory. More than ever is it true, that by far the best, most probable and most convincing interpretation of the facts of paleontology is that offered by the theory of evolution.

This result is all the more striking when the state of the other sciences in 1859 is taken into consideration. Physics, chemistry, astronomy, and even mathematics, have been more or less completely reconstructed since that time. The principal theories which then dominated physics and chemistry have nearly all been abandoned in favor of newer interpretations. The advance of discovery has been fatal to the older conceptions. This is not true of the theory of evolution which, as stated above, is more thoroughly established and more universally accepted than ever before.

In 1876-7 Huxley delivered a series of lectures on evolution in New York; and the lecture entitled (I quote from memory) "The Demonstrative Evidence of Evolution" was devoted to the discoveries of American paleontology, and more particularly to the genealogy of the modern horses, as that had been worked out by Professor Marsh. Huxley himself had been the first to attempt a scheme of equine evolution; but, as he had access only to European material, he could make but an approximation to the later conceptions. When he saw Marsh's finely preserved fossils, arranged in chronological order, he was convinced that he had before him an actual and positive demonstration of the evolutionary theory. It wasn't that, perhaps, but it was evidence of so high a degree of probability as to be convincing. That Leidy, though a thorough-going evolutionist, has little to say concerning the interpretation of the fossils, which he discovered and described, seems at first sight surprising. But he was, in fact, laying the foundations of the theoretical structure. It was he who first showed the chronological stages and modifications in the history of many families, horses, camels, rhinoceroses, wolves, cats, etc.; and that he did not categorically draw the obvious conclusions was due to his belief that theoretical discussions should wait upon the acquisition of more complete material.

These are the more important of the applications of paleontology. Can it be a matter of surprise that Leidy, with his remarkably clear and broad outlook over the world of nature, should have felt that paleontology was the main work of his life?

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THE CONTRIBUTION OF BIOLOGY, CHEMISTRY AND PHYSICS TO THE NEWER KNOWLEDGE OF RICKETS[1]

THE investigation of rickets is an outstanding example of the value of interweaving the basic sciences with clinical medicine and may well serve as a text to illustrate "the contributions of other sciences to medicine." It is an axiom that many disorders have been elucidated only with the aid of chemistry and animal experimentation, but the instances are few in which biology, inorganic and organic chemistry and various forms of physics have been resorted to so frequently and to such a degree. Although decreasing in incidence and severity, rickets still undoubtedly is the most common nutritional disorder of early childhood in the temperate zones. It has been the object of intermittent study ever since Glisson first described signs and symptoms of the "Englische Krankheit" in 1650. Our acquisition of knowledge concerning its various aspects may

[1] Presented as part of a symposium on "The contributions of other sciences to medicine" at the annual meeting of the American Association for the Advancement of Science, Nashville, Dec. 28, 1927.

be divided broadly into two periods, the one—which may be termed the clinical and pathologic era—comprises the long span between 1650 and 1918, and the other—that of "the newer rickets"—embraces less than a decade, from 1918 until to-day. The latter period, which is still in full fruition, is an indirect result—a by-product—of the discovery of the vitamins. Using this new concept as a fulcrum, and abandoning the old and fixed idea of producing rickets experimentally by limiting the intake of calcium, Mellanby successfully brought about this disorder in puppies by depriving them of a specific fat soluble factor. It is true that he mistook what we now recognize as the fat-soluble vitamin for the antirachitic factor, but there can be no doubt but that he succeeded in inducing true rachitic lesions. Shortly thereafter investigators in this country—McCollum and his coworkers, as well as Sherman and Pappenheimer—produced typical histologic lesions in the rat by means of rations deficient in phosphorus.

The first factor which led to the era of "the newer rickets" emanated therefore from the biologic or physiologic laboratory and, as has been the case so often in connection with infectious as well as nutritional disorders, consisted of the ability to reproduce at will a disorder in an experimental animal. The second propelling influence following on the heels of the first, although having no connection with it, was the demonstration by Huldschinsky in 1918 of the importance of light, of the fact that ultra-violet radiations are a specific preventive or curative antirachitic agent. From this time until to-day, rickets—which for two and a half centuries had awakened but a fitful interest in the clinician—has been the object of intense investigation in many of the biologic, chemical and physical laboratories both in this country and abroad.

The earliest and simplest chemical studies were carried out in the clinic. Iverson and Lenstrup, of Copenhagen, as well as Howland and his coworkers in this country, showed the old conception to be erroneous which held that a deficiency of calcium is the essential disturbance in rickets, and proved that it is the phosphorus ion which dominates the metabolic picture. The inorganic phosphorus of the blood was found to be low. Indeed, due to the wide prevalence of rickets, it was shown later that there is what may be termed "a phosphate tide" in the blood of infants, an ebb during the winter months followed by a flood in the spring with the advent of sunshine. We shall find that the later chemical studies, those on the sterols, have been far more complex and have taxed to the utmost the resources and ingenuity of experienced organic chemists.

Up to this time chemistry and pathology had aided the clinician in the solution of his problems. As soon as it had been demonstrated that certain light waves are a specific curative agent, it was necessary to turn to physics for information. Naturally, the first point of attack was the segregation and definition of the specific radiations which were endowed with this remarkable therapeutic property. By means of filters of known penetrability it was soon found that ultra-violet radiations of greater length than about 320 μμ, or 3,200 engstrom units, were unable to protect animals from rickets which were fed a diet deficient either in phosphorus or in calcium. This observation proved to be of interest not only to clinicians but to the large number of workers who were actively engaged in studying various biological processes, for example, the growth of plants, or the factors involved in egg production and fertilization or the rôle of light in the cultivation of cells *in vitro*. *To-day rickets has become the established criterion for appraising the biologic action of ultra-violet waves in the region of 300 millimicrons.*

In 1924, less than four years ago, it was shown by me and almost simultaneously by Steenbock that the specific ultra-violet radiations exert their action not only on animals exposed to their influence, but also indirectly on various foodstuffs. As is well known, milk, flour, oils, cereals, etc., can be rendered antirachitic by this means—activation being restricted to the same band of ultra-violet light as in the case of animals. This newer knowledge, combining as it did physical and chemical aspects, led to renewed activity in these fields of endeavor. The first question was to attempt to discover the substance in the food which underwent this remarkable transformation. This study, although having made steady progress, is still incomplete and is being actively pursued in various laboratories both in this country and abroad. It was ascertained within a few months that it is the non-saponifiable fraction and not the fat in the foods which is essential to activation. At the end of 1924 both Steenbock and I were able to report that it is the cholesterol in the animal cell, or phytosterol, its counterpart in the vegetable cell, which undergoes specific alteration. Cholesterol purified by repeated crystallizations, which from the standpoint of rickets is inert, could be rendered highly antirachitic by subjection to ultra-violet irradiation for a minute or less. Its melting-point, specific rotation and chemical constitution had undergone no apparent change in the course of the procedure, and it seemed as if the new product were an isomer of cholesterol. During this period studies were being carried out concurrently in the physical laboratory. The problem of the activation of cholesterol lent itself readily to an investigation by means of absorption spectra. It was found

that the well-known absorption bands of cholesterol were definitely altered as a result of irradiation, that the sterol becomes more permeable to certain definite wave-lengths of ultra-violet light. This work, into which we shall not enter in detail, was first undertaken in this country, and has more recently been refined and extended by Heilbron in Liverpool, and Pohl in Goettingen. Furthermore, by means of the use of monochromatic ultra-violet light, it was shown that the uppermost limit of the antirachitic field may be placed at 313 μμ, and that even at this point its action is feeble. When we bear in mind that the shortest rays of the sun which reach the surface of the earth rarely are less than 300 mm. in length, it is evident how circumscribed is the area of specific solar radiations. *A difference of a few millimicrons or millionths of a millimeter determines whether or not waves are specific or ineffective.*

It was soon evident that only a very small fraction of the cholesterol becomes activated following irradiation, less than one per cent. This observation raised the question in the minds of several investigators, as to whether it is truly the cholesterol which is transformed or some associated sterol—a subject which during the past year has been studied by Windaus and myself, as well as by Rosenheim and his coworkers in London. It developed that another unsaturated sterol—a sterol with 3 unsaturated bonds—is mainly concerned in the elaboration of the antirachitic factor, namely ergosterol, which heretofore has been extracted from ergot and from yeast, but which is now being found more widely distributed in nature. It would lead too far afield to discuss the moot question of the activation of cholesterol and other sterols. In brief, it may be stated that it has not been shown definitely that cholesterol, as well as ergosterol, can not be activated. In this connection, the minuteness of the amount of irradiated ergosterol required to protect an animal should be emphasized; it has been found that *1/10,000 of a milligram or 1/10,000,000 of a gram daily is sufficient to confer protection.* When we bear in mind that this infinitesimal amount is given by mouth, it is difficult to conceive that the specific antirachitic factor exerts its curative action directly and bodily on the various epiphyses throughout the body.

Parallel with these investigations on ultra-violet radiations and the sterols, which engaged the attention of the physicist and of the chemist, the question was being considered as to how these newer ideas could be brought into consonance with the well-established fact of the specific antirachitic properties of cod-liver oil. At first the two phenomena seemed irreconcilable, but, as you know, it soon was demonstrated that the activity of cod-liver oil in rickets rests on the same basis as that of foods which have been subjected to irradiation—that both are dependent on the action of a specific sterol. In passing, it should be added, however, that it has not been shown that the therapeutic activity of cod-liver oil is confined to the effect of this sterol.

In my review of this subject, it has been necessary to treat the advances in the fields of biology, chemistry and physics as if they took place consecutively. As a matter of fact, they have progressed at one and the same time, new discoveries by the physicist being made at once the basis for some newer chemical investigation and both in turn leading perhaps to interesting developments in the provinces of experimental biology or clinical therapeutics. Some of these studies have been carried out in conjunction or close cooperation with the clinic, others have been made in laboratories devoted solely to investigations in pure science. In the light of recent studies of the vitamins and hormones, it would seem that, in general, this probably will be the method—if it can be called a method—of advancement in the future. It is questioned often whether newer technics and discoveries in medicine will be evolved by the clinician in ward and laboratory, or whether, as it becomes necessary to delve ever deeper into the realms of pure science, the clinician, in spite of his modern training, will not become dependent upon the discoveries of the physicist, the chemist and others occupied with the basic sciences.

No one can answer this question with any degree of certainty. It seems probable nevertheless that for some time to come the clinician—owing to his strategic position in the broad realm of medicine—will continue to make valuable and even basic contributions to our store of knowledge, and that the recent experience in the field of rickets will from time to time be repeated in other provinces of clinical medicine. It can, however, be safely predicted that in order to gain this newer knowledge we must once more call to our aid in varying degree biology, chemistry and physics.

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ACOUSTICS OF AUDITORIUMS*

A CONSIDERATION of recent investigations led the writer logically and unexpectedly to the conclusion that good acoustics in an auditorium may be obtained by making it like the outdoor theater of the Greeks. Also, it is concluded that better acoustics appears likely if a study is made of the way in which speech and music are generated, with special consideration

* An address given March 1 at the Physics Colloquium, University of Illinois.

of the effect of the sound reflected from walls near the speaker or musician.

Very little was known scientifically about acoustics of auditoriums until W. C. Sabine, about 1900, began to publish the results of his work.[1] Aside from occasional minor faults or interference and resonance, Sabine concluded generally that the acoustics of a room depended mainly on the reverberation or decay of sound. He conducted an extensive and careful series of investigations which showed that the time taken for a standard sound to die out in a room depended on the loudness of the sound and on the volume of the room, and inversely on the absorption of the surfaces in the room. Most of the investigations since then have only amplified and extended Sabine's fundamental conclusions.

As a result of these efforts, auditoriums have been greatly improved in acoustical qualities, so much so that attempts have been made to specify "optimum" conditions,[2] with the hope of securing perfect acoustics. Auditoriums adjusted according to these conditions, while generally satisfactory, have not always given the expected perfect effects. In some cases, speakers and musicians have voiced objections without being able to state clearly what the trouble was.

In the meantime, within the past two or three years, several publications have appeared that yielded information from different viewpoints than those given originally by Sabine and that furnish possibilities of improving acoustic effects. That is, while Sabine investigated primarily the reverberation and decay of sound, these later studies deal more particularly with the growth of sound in a room.

For instance, Petzold[3] has shown that blurring (Verwischung) will be set up if two identical speech sounds reach an auditor with a time interval between them of .05 second or more. This would be the case if two speakers were separated about fifty-six feet and uttered the same words simultaneously. While it is practically impossible for two speakers to do this, the effect may be obtained by a single speaker who stands near a reflecting wall so that his acoustic image on the other side of the wall may be thought of as saying the same words as the speaker and at the same time. The image is really due to the reflected sound. For music, Petzold finds a shorter time limit between two sounds of .035 to .042 second, depending on the character of the music.

This conclusion of Petzold's indicates the importance of studying the reflecting surfaces near speakers and musicians to avoid blurring effects. Usually in auditoriums, the space about the performer has been decided by other requirements than acoustics. The large stage house of the modern theater gives little practical opportunity for suitable reflecting walls. In smaller auditoriums, it would be easier to design such reflectors, without the usual heavy absorbing curtains.

Such reflecting surfaces should preferably be plane, and situated not more than about twenty feet from the performer—a smaller distance would give better results—and inclined so as to reflect sound to the audience. Under these circumstances, the direct sound from the performer is reenforced without distortion by a number of images, all giving simultaneously the same sound.[4]

Not only are the auditors benefited by this arrangement, but the performer himself gets an immediate response to his effort that allows him to adjust his speech or music to get the best effect. Without this, the performer feels lost, and the resulting sound, particularly music, lacks perfection. Musicians state that they prefer to sing or play near a wall—and always with a resonant stage floor, without carpet—presumably because of the reassuring support given by such reflecting surfaces.

An experiment of this nature recently performed by the writer supports this view. A reflector, twelve by fourteen feet, was hung horizontally over a band stand, and, by means of ropes and pulleys, could be raised or lowered. When the reflector was lowered successively to positions twelve, ten, eight and seven feet above the players, the acoustic conditions were improved. The comments of the players were: "Plays easier," "Tones are more natural," "Gets better as the reflector gets lower," "Tones are smoother," etc. The resultant music in the hall for auditors was also better as the reflector was lowered.

Petzold[5] describes some uses of reflecting surfaces about orchestras and choruses. An orchestra pit, for instance, is a resonant enclosure that allows the music to be reenforced and blended beneficially before it goes out to the audience. "Sounding" boards are advantageous if they have sufficient size and if placed intelligently in accordance with acoustic principles.

Another investigator[6] obtains values of the resultant sound as it builds up and dies out at various points in an auditorium. By means of a condenser-transmitter, amplifying device and oscillograph, he obtained curves

[1] "Collected Papers on Acoustics," 1922.

[2] S. Lifshitz, *Physical Review*, 25, 391, 1925; 27, 618, 1926; F. R. Watson, *Architecture*, LV, 251, 1927.

[3] Ernst Petzold, "Elementare Raum Akustik," 1927, p. 8.

[4] F. R. Watson, "Acoustic Design of Churches," *Western Architect*, XXXVI, 178, 1927.

[5] *Loc. cit.*, Chap. 10.

[6] F. Trendelenburg, "Experimentalbeitrag zur Raumakustik," *Zts. für Tech. Physik*, No. 11, 1927.

of the resulting sound. In certain positions near the source of sound, where the reflected sound arrived some time after the direct sound, it was easy to understand the speaker. At considerable distances from the speaker the reflected sound was of more influence and the understanding of speech was difficult. He concluded that good speech understanding would be obtained only at points where the direct sound predominated.

In another connection, Petzold[7] calculated the value of the direct sound at a point 18.1 meters from the source in a room 30 x 20 x 12 meters in volume, and estimated also the added effect of the reflected sound. Neglecting interference phenomena, he assumes that the direct sound gives 10,000 "Vox" (where the Vox is the arbitrary unit of intensity of a sound produced by a special organ pipe used). To the direct sound, the beneficial reflections, that is, those that arrive quickly enough to avoid blurring the direct sound, add enough to give a total of 31,210 Vox. The resultant is then about three times as intense as the direct sound, but the loudness, as perceived by a listener, is less than this, being proportional to the logarithm of the intensity. The relative effects for auditors are the logarithms of 10,000 and 31,210, or 4 and 4.5, respectively; that is, the beneficial reflected sound contributes one half unit to the four units of the direct sound, or only one ninth of the total sound.

From these calculations, it would appear that the reflected sound could be omitted entirely without vital consequence—a conclusion that is quite contrary to the usual conception of auditorium acoustics, where the reflecting walls are supposed to be quite beneficial in increasing the loudness. Omitting the reflected sound would have the advantage of eliminating any possible blurring defects of reflection, as previously described. But this arrangement surprisingly suggests the open-air theater, such as was used by the Greeks, with no reflecting surfaces except the wall at the rear of the stage, and generally regarded as having very good acoustics.

A book[8] on outdoor theaters bears out this supposition about satisfactory acoustics. For example, we read, "Outdoor theaters differ considerably with regard to acoustic qualities, but in general it is surprisingly easy in any of them to hear what is said or sung on the stage." Regarding the Garden Terrace Theater at Yankton, South Dakota, the author writes, "The acoustic properties are a surprise to every one. At the extreme rear, 180 feet from the stage, an ordinary stage or platform voice is perfectly clear and satisfactory." In the Greek theater at the University of California, that holds an 8,000 audience, one can see and hear in every seat. Again, "The acoustic qualities of the theater (Isis Theater, Point Loma, California), like those of every other outdoor theater without exception, are spoken of as remarkable." And so on for other theaters.

An experiment by the writer furnishes a suggestive example. In an investigation on "Optimum Conditions for Music in Rooms,"[9] the fact was brought out that musicians preferred a reverberant space to play in, but that auditors found "dead" surroundings preferable for listening. What was done was first to adjust a room of approximately 6,500 cubic feet volume to give "optimum" reverberation by placing sound-absorbing material about the walls. A quartette of musicians (three violins and a cello) then played at one end of the room. They did not like the musical effects, nor were the auditors pleased. But when the absorbing material was transferred from the walls about the musicians to the end of the room occupied by the listeners, the musical effects for both playing and listening improved until, in the final stage, they were thought "perfect." This arrangement appears to imitate an outdoor theater. The "dead" conditions surrounding the listeners are repeated outdoors by the perfect absorption of the open sky, but there would be some reflection from the leaves of trees and plants.

An experiment by Sabine[10] was performed in which absorbing material was brought into a music studio until the musicians present thought the conditions were satisfactory. This was repeated in several other similar studios. Sabine then found in subsequent experiments that the average time of reverberation for rooms of this size was 1.08 seconds, thus indicating that an optimum reverberation exists for players, that is, for the generation of sound.

Lifshitz[11] conducted a similar experiment in a room of 265 cubic meters volume holding an audience of 120 persons. By varying the number of auditors he could conveniently change the absorption—due to clothing—and thus control the time of reverberation. Opinions were given concerning the acoustic effects, so that he arrived at an average optimum time of 1.11 seconds. Earlier experiments in a room of 126 cubic meters volume gave 1.03 seconds as the optimum. Averaging four values—Sabine, 1.08 sec., Watson ("Acoustics of Buildings," p. 51), 1.04 sec., Lifshitz, 1.11 and 1.03 sec.—he obtained 1.06 seconds as the

[7] *Loc. cit.*, p. 74.

[8] Frank A. Waugh, "Outdoor Theaters," 1917.

[9] SCIENCE, LXIV, 207, 1926.

[10] "Accuracy of Musical Taste," Proc. Amer. Acad. Arts and Sciences, XLII, June, 1906.

[11] "Mean Intensity of Sound in an Auditorium and Optimum Reverberation," *Phys. Rev.*, 27, 618, 1926.

optimum value for reverberation for rooms of this size. While these experiments allowed an optimum to be estimated for the reverberation or decay of sound, the writer is led to ask if the listening musicians in each case did not primarily pronounce an opinion on the generation of sound rather than the decay.

Experiments by Knudsen[12] show that speaking is better understood as an auditorium is made successively "deader" with sound-absorbing materials, thus imitating an outdoor theater. He found[13] for an open-air theater (Hollywood Bowl, Los Angeles) that a listener one hundred feet from the speaker could understand speech better than in the most satisfactory Los Angeles theater. Lifshitz (*loc. cit.*) found the same effect, but thought the speech lost its musical quality and became dry and lifeless.

The Eastman Theater, Rochester, New York, gives further information in this regard. Some apprehension was felt in designing the acoustics of this theater[14] whether or not music would be heard distinctly on the mezzanine balcony. The opening to this balcony, under the main balcony, was comparatively small and it seemed likely that only a small amount of sound would enter. Also, this space was furnished with a considerable amount of sound absorption in the upholstered seats and carpet. On completion of the theater, however, the reception of music on this floor was thought superior to other locations. Here again it appears advantageous to have conditions for listening quite dead acoustically.

From the investigations cited in this article, the writer is led to draw certain conclusions and to make suggestions for further experimental work. That is, the problem of the acoustics of auditoriums is twofold—first, a study of the generation of sound and its building-up processes, which are practically completed in one or two tenths of a second; and second, a study of the decay of sound. The latter feature has been studied extensively by Sabine and his followers, but further investigation of the growth of sound appears promising in securing important information.

The growth of sound and the decay of sound are not independent processes, because the absorption of the room affects both. What is desired apparently is to have the time of reverberation shortened sufficiently so that the successive sounds of speech and music will be given opportunity for suitable development without possibility of serious overlap and distortion.[15] Increasing the absorption allows a sound to rise more quickly to its maximum value, and also increases advantageously the rate of decay so that the field is cleared for the next sound.[16]

Further information on the relative adjustment of the growth and decay of the sound is given by the investigations of the "masking" of one tone by another. For instance, Wegel and Lane[17] showed that the masking of two tones was greatest for tones nearly alike. Also, they found that loud tones more easily masked tones of high frequency than those of low frequency. Knudsen[18] showed that noise had more effect than a pure tone on another tone. He states also, "For good hearing in an auditorium, the speech energy should be from 1,000 to 10,000 times the energy of any interfering noise." These investigations would indicate how much two sounds could overlap without serious distortion.

The various investigations discussed lead the writer to suggest the possibility of an "indoor-outdoor" theater; that is, an indoor theater that incorporates the good acoustics of an outdoor theater. An investigation should be made to improve, if possible, the stage conditions of the outdoor theater.[19] A stage with a wooden floor, a vertical rear wall, diverging side walls and a sloping ceiling gives promise of beneficially reenforcing speech and music and also of developing enough resonance so that the speaker can better judge the effect of his voice. The use of thin, resonant reflecting boards would yield some interesting effects. On the other hand, it would be instructive in an indoor theater, to have the auditorium quite dead—comparable with outdoors—but to try a stage similar to the one just described. Additional information is needed about the resultant speech effects at different points in a room; that is, a photograph of the vibrations set up by words and music of different kinds when sound-waves cross each other. Some attempts in these directions are being tried by the writer, but cooperation of others in this apparently important development appears desirable.

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[12] V. O. Knudsen, *Physical Review*, 26, 287, 1925.

[13] *The Architect and Engineer*, September, 1926.

[14] Watson, "Acoustics of Buildings," p. 49.

[15] Trendelenburg, *loc. cit.*; E. A. Eckhardt, "The Acoustics of Rooms," *Jour. Franklin Inst.*, 195, 799, 1923; E. Michel, "Horsamkeit Grosser Räume," p. 8.

[16] Watson, "Acoustics of Buildings," p. 16.

[17] "Auditory Masking of One Pure Tone by Another," *Phys. Rev.*, 23, 266, 1924.

[18] "Interfering Effect of Tones and Noise Upon Speech Reception," *Phys. Rev.*, 26, 133, 1925.

[19] R. Berger, "Die Schalltechnik," p. 61; Davis and Kaye, "The Acoustics of Buildings," chap. VII.

SCIENTIFIC EVENTS

THE POPULATION OF THE UNITED STATES

THE Department of Commerce announces an estimate of the population of the United States made by the Bureau of the Census. This gives a total estimated population of 120,013,000 on July 1, 1928, as compared with 105,710,620 on January 1, 1920. The total is arrived at by estimating the increase since 1920 upon the basis of the available data regarding births, deaths, immigration and emigration. The population of the several states is then estimated by distributing the total increase for the United States upon the basis of the increase by states from 1910 to 1920 or, where there has been a state census, from 1920 to 1925, except that where there was a decrease between 1910 and 1920 or between 1920 and 1925, the 1920 or 1925 census figure is retained, and no estimate is made:

	Census Jan. 1, '20	Estimated July 1, '28
United States	105,710,620	120,013,000*
Alabama	2,348,174	2,573,000
Arizona	334,162	474,000
Arkansas	1,752,204	1,944,000
California	3,426,861	4,556,000
Colorado	939,629	1,090,000
Connecticut	1,380,631	1,667,000
Delaware	223,003	244,000
District of Columbia	437,571	552,000
Florida	968,470	1,411,000
Georgia	2,895,832	3,203,000
Idaho	431,866	546,000
Illinois	6,483,280	7,396,000
Indiana	2,930,390	3,176,000
Iowa	2,401,021	2,428,000
Kansas	1,769,257	1,835,000
Kentucky	2,416,630	2,553,000
Louisiana	1,798,509	1,950,000
Maine	768,014	795,000
Maryland	1,449,661	1,616,000
Massachusetts	3,852,356	4,290,000
Michigan	3,668,412	4,591,000
Minnesota	2,387,125	2,722,000
Mississippi	1,790,618	1,790,618†
Missouri	3,404,055	3,523,000
Montana	548,889	548,889‡
Nebraska	1,296,372	1,408,000
Nevada	77,407	77,407†
New Hampshire	443,083	456,000
New Jersey	3,155,900	3,821,000
New Mexico	360,350	396,000
New York	10,385,227	11,550,000
North Carolina	2,539,123	2,938,000
North Dakota	646,872	641,192§
Ohio	5,759,394	6,826,000
Oklahoma	2,028,283	2,426,000
Oregon	786,389	902,000
Pennsylvania	8,720,017	9,854,000
Rhode Island	604,397	716,000
South Carolina	1,683,724	1,864,000
South Dakota	636,547	704,000
Tennessee	2,337,865	2,502,000
Texas	4,663,228	5,487,000
Utah	449,396	331,000
Vermont	352,428	352,428†
Virginia	2,309,187	2,575,000
Washington	1,356,621	1,587,000
West Virginia	1,463,701	1,724,000
Wisconsin	2,632,067	2,953,000
Wyoming	194,402	247,000

* Provisional estimate data regarding births, deaths, immigration and emigration from 1927 to 1928 not being available.

† Population, January 1, 1920; decrease 1910 to 1920.

‡ Population, January 1, 1920.

§ Population, State Census, 1925.

APPROPRIATIONS BY THE COMMONWEALTH FUND

THE board of directors of the Commonwealth Fund at their February meeting appropriated $358,438 for the fund's rural hospital program. During the last two years five awards have been made under this program for hospitals in Farmville, Va.; Glasgow, Ky.; Farmington, Me.; Beloit, Kans., and Wauseon, Ohio. In each case the Commonwealth Fund provides two thirds of the cost of construction and equipment, while the community pays the remainder of the cost and assumes the expense of operation.

At the same meeting $27,000 was appropriated for fellowships in psychiatry at the University of Colorado Medical School. Six such fellowships, each with a stipend of $4,500 for two years' study, will be offered to graduates of class A medical schools who intend to specialize in psychiatry. The University of Colorado, in affiliation with the Colorado Psychopathic Hospital, which was opened three years ago under the direction of Dr. Franklin Ebaugh, is regarded as offering unique opportunities for the training of psychiatrists in that part of the country.

Five three-year fellowships for psychiatrists at the Henry Phipps Psychiatric Clinic, under the direction of Dr. Adolph Meyer, the Johns Hopkins University, Baltimore, were also provided for with a grant of $45,000.

A grant of $4,750 for operating expenses was made to the New York City Committee on Mental Hygiene with a possibility of renewal for two subsequent years. This committee was organized in May, 1927, as one of the local branches of the New York State Committee on Mental Hygiene affiliated with the State Charities Aid Association. Dr. C. Floyd Haviland, superintendent of the Manhattan State Hospital, is chairman

of the committee and Mrs. Sydney C. Borg, of the Jewish Board of Guardians, is vice-chairman. The committee will function as the mental hygiene section in the health division of the Welfare Council of New York City and it expects to develop a unified mental hygiene program for New York City.

Other appropriations made at the February meeting included $10,000 to the National Probation Association for the further development of its field service department; $15,000 to the Foreign Language Information Service; $3,800 for the cardiac clinic of the Johns Hopkins University Hospital, and $2,000 for scholarships at the Southern Pediatric Seminar. The latter grant renews one of the same amount made for the summer of 1927, under which 35 scholarships were awarded to physicians from six southern states to attend this seminar, which is held for two weeks each summer in Saluda, N. C., in order to enable general practitioners to gain further clinical information concerning methods of diagnosis, treatment and prevention of children's diseases.

At the preceding meeting of the board of directors of the Commonwealth Fund, held in December, the following appropriations were made: For the child health program of the Commonwealth Fund, $230,000; for projects in legal research to be conducted by the law schools of Chicago, Yale and Harvard Universities, $25,000; for surveys of rural health work, under the direction of the Committee on Administrative Practice of the American Public Health Association, $22,500; to the National Conference of Catholic Charities for a study of child-caring homes, $16,500; for a two-year study of encephalitis cases at the Pennsylvania Hospital, $10,000; for the general budget and the department of institutional care of the Child Welfare League of America, $10,000; for the cardiac work of the New York Tuberculosis and Health Association, $7,500.

THE FOURTH PACIFIC SCIENCE CONGRESS

ANNOUNCEMENT has recently been made that the fourth Pacific Science Congress, sponsored by the Pacific Science Association, will be held under the auspices of the Netherlands Indies Pacific Research Committee in Batavia and Bandoeng, Java, from May 16 to 25, 1929.

The program for the congress will be organized in three divisions, including physical sciences, biological sciences and agricultural sciences, the latter group having been added to the major divisions recognized at earlier congresses because of the dominating economic and scientific interests of agriculture in the colonies of the Netherlands Indies. As in the previous congresses most of the sessions of the divisions will be given over to symposia upon selected problems.

Papers for these symposia are invited from American scientists upon any important scientific problems pertaining to the Pacific region in these three general fields. The plan for organizing the program for the congress contemplates requesting men who are competent to speak upon the scientific problems of the region to summarize groups of related papers offered and to present briefly at these symposia a coordinated review of these contributions, in order to relate each group of papers to its problem as a whole and preserve as large an opportunity as possible for discussion. Abstracts, in duplicate, of all papers offered for the program of the congress should be in the hands of the first general secretary of the congress, Dr. H. J. Lam, Botanical Gardens, Buitenzorg, Java, by January 1, 1929, and the complete papers, also in duplicate, should be forwarded to Dr. Lam as soon as practicable after that date, so as to permit adequate consideration of the papers in the preparation of the program.

For several days both before and after the period of the scientific meetings, excursions have been planned which will make it possible for visiting scientists to see many things in Java which are of particular scientific significance, as well as the scenic features of the island and its agricultural developments.

VERNON KELLOGG
NATIONAL RESEARCH COUNCIL

AWARD OF FELLOWSHIPS BY THE GUGGENHEIM FOUNDATION

FELLOWSHIPS of an aggregate value of $173,000 have been awarded by the John Simon Guggenheim Memorial Foundation to seventy-five young American scholars, scientists and artists. The usual stipend, $2,500, for one year, will enable the beneficiaries to spend all or part of the coming year in study and research abroad.

The following is a list of awards in the field of science:

Dr. Willem Jacob Luyten, assistant professor of astronomy at Harvard University: to photograph the southern sky with the Bruce telescope of the Harvard Observatory at Mazelspoort, South Africa, with a view to comparing these plates with similar plates taken between 1896 and 1905 to obtain information concerning the numbers, velocities and intrinsic brightnesses of the stars in the neighborhood of the sun.

Dr. Otto Struve, assistant professor of astrophysics at the University of Chicago, a theoretical study of the distribution and physical properties of diffuse matter in

interstellar space, with Professor A. S. Eddington, at Cambridge University.

Dr. Olive C. Hazlett, assistant professor of mathematics at the University of Illinois: to study the arithmetics of linear associative algebras together with their application and interpretation in other lines of mathematics, in Europe.

Dr. Perry Byerly, assistant professor of seismology in the University of California: to study mathematical geophysics in order to apply data already obtained in the study of the Montana and other American earthquakes to the problems of the nature and position of these discontinuities in the earth's structure which lie above the central core.

Dr. J. J. Hopfield, assistant professor of physics at the University of California: to study the Zeeman effect of the infra-red spectra of oxygen and nitrogen with reference to the classification of the extreme ultra-violet spectra of these elements, with Professor F. Paschen, at the Imperial Physico-Chemical Institute, Charlottenburg, Germany.

Dr. R. J. Kennedy, research associate in physics at the California Institute of Technology: to do research towards establishing a consistent theory of radiation, with Professor Sommerfeld at Munich and Schrödinger at Berlin.

Dr. Noel C. Little, professor of physics at Bowdoin College: to determine the thermo-magnetic properties of gaseous molecules by a new method of convective flow with a view to the study of their structure and special quantitization, with Professor W. Gerlach at Tubingen.

Dr. F. W. Loomis, associate professor of physics at New York University: to make a study of the new quantum mechanics, especially in relation to problems in band spectra, with Professor T. Frank at Göttingen and Professor Schrödinger at Berlin.

Dr. L. E. Reukema, assistant professor of electrical engineering at the University of California: to make a theoretical and experimental study of electric discharge of gases at high frequencies and of the breakdown of solid insulating materials under high electric stress, with Professor W. O. Schumann at Munich.

Dr. W. W. Watson, assistant professor of physics at the University of Chicago: to study molecular spectra under Professor Frank of Göttingen and Sommerfeld of Munich, with a view to learning more about the structure of molecules and the nature of chemical reactions.

Dr. Richard Bradfield, assistant professor of soils at the University of Missouri: to investigate some of the principles involved in the purification of colloids by electrodialysis (reappointment).

Dr. G. H. Coleman, assistant professor of chemistry at the State University of Iowa: to carry out an experimental study of a new method for the preparation of amines by the reaction of organomagnesium halides with chloramines and related compounds, with Professor Victor Grignard at the University of Lyons.

Dr. Earl C. Gilbert, associate professor of chemistry at the Oregon State College: to make an experimental study of some hitherto uninvestigated reaction of hydrazine from the standpoint of modern theories of solution, catalysis and electronic structure; principally with Professor J. N. Bronsted, of the Polytechnic Institute, Copenhagen.

Dr. Ralph E. Cleland, associate professor of botany at Goucher College: to make studies of the chromosome constitution and behavior in the evening primrose.

Dr. R. B. Harvey, associate professor of plant physiology and botany at the University of Minnesota: to investigate the effects of low temperature on plants, in Northern Russia.

Dr. Warren K. Stratman-Thomas, research pharmacologist of the University of Wisconsin: to determine by clinical trial the therapeutic value of certain new arsenical compounds in the chemotherapy of sleeping sickness, with Dr. Clement C. Chesterman, in the Belgian Congo.

Dr. Homer W. Smith, professor of physiology at the University of Virginia: to go to Naples, Cairo and Khartum to make physiological studies of rare species of lung fishes surviving in the waters of the Nile and Mediterranean.

Dr. Dwight E. Minnich, associate professor of zoology at the University of Minnesota: to make physiological studies on the chemical senses of insects, principally with Professor Karl V. Frisch, director of the Zoological Institute at the University of Munich.

Dr. Emmett R. Dunn, associate professor of zoology at Smith College: to carry out researches on Central American reptiles and amphibians, and on the salamanders of the family Ambystomidae, field work in Mexico and Costa Rica and study in European museums.

Dr. William V. Cone, instructor in surgery at the Columbia University College of Physicians and Surgeons: to study the reactions of the interstitial cells of the central nervous system, with Dr. Gordon Holmes at the National Hospital for the Paralyzed and Epileptic in London.

Dr. R. R. Dieterle, instructor in psychiatry at the University of Michigan: to study the spirochetosis of the central nervous system in the syphilitic diseases affecting the nervous tissues, with Professor F. Jahnel, in Munich.

Dr. John C. McKinley, associate professor of neuropathology at the University of Minnesota: to make quantitative studies on human muscle tonus at the University of Breslau, Germany.

SCIENTIFIC NOTES AND NEWS

SIR THOMAS HOLLAND, of the Imperial College of Science and Technology, has been nominated by the council to be president of the British Association for the Advancement of Science for the 1929 meeting, which is to be held in South Africa.

ON the occasion of the Harvey tercentenary meeting of the Philadelphia College of Physicians on March 22, Jefferson Medical College and the University of Pennsylvania conferred the honorary doctorate of laws upon Sir Humphry Davy Rolleston,

physician-in-ordinary to King George of England, and the degree of doctor of science on Dr. J. J. R. Macleod, professor of physiology in the University of Toronto.

DR. ADOLPH ENGLER, professor of botany at the University of Berlin, has been elected an honorary member of the Russian Academy of Sciences.

M. BOUIN, professor of histology in the University of Strasbourg, and M. Bardier, professor of pathology in the University of Toulouse, have been elected corresponding members of the French Academy of Medicine.

DR. PAUL KOEBE, professor of mathematics in the University of Leipzig, has been awarded the international mathematics prize of the Swedish Academy of Sciences.

PROFESSOR W. H. HOFFMANN, of the Finlay Laboratory, Havana, has been elected a fellow of the Royal Society of Tropical Medicine and Hygiene, London.

SEBASTIAN L. DE FERRANTI, past-president of the Institution of Electrical Engineers of Great Britain, has been elected a fellow of University College, London.

THE February issue of the *Deutsche Zeitschrift für Chirurgie* is dedicated to Professor Alexander Fraenkel, director of the surgical division of the General Policlinic of Vienna, on the occasion of his seventieth birthday.

DR. L. A. ROGERS, director of the research laboratories of the U. S. Bureau of Dairy Industry, who, on July 1, completed twenty-five years of continuous service in the Department of Agriculture, was guest of honor at a dinner given at the Cosmos Club on the evening of March 3. The occasion was the formal presentation of the book entitled "Fundamentals of Dairy Research," written by Dr. Rogers's associates and dedicated to him in recognition of his leadership and his many outstanding scientific contributions and as an expression of the high regard in which he is held.

A WILLIAM SNOW MILLER lectureship has been established at the University of Wisconsin Medical School by the Phi Beta Pi fraternity in connection with the seventieth birthday of Dr. William Snow Miller, emeritus professor of anatomy at the university. Dr. T. Wingate Todd, of Western Reserve University, will discuss "The Medieval Physician" soon as the first of the series of lectures.

DR. CHARLES SHEARD, of Rochester, Minn., and Dr. Howard C. Doane, president of the Massachusetts Board of Registration in Optometry, have been selected as recipients of the first gold medals of the Distinguished Service Foundation of Optometry.

PROFESSOR C.-E. A. WINSLOW, Lauder professor of public health in the school of medicine at Yale University has been awarded the Ling medal by the Ling Foundation of Los Angeles, "in appreciation and recognition of Professor Winslow's active and unselfish work in behalf of the health progress of school children."

ON account of blindness, Professor Thomas E. McKinney, of the department of mathematics and astronomy at the University of South Dakota, will retire from service at the end of the present university year.

PROFESSOR CHARLES B. BREED, of the Massachusetts Institute of Technology, was elected president of the Boston Society of Civil Engineers at its eightieth annual meeting.

DR. L. H. ADAMS, of the Geophysical Laboratory of the Carnegie Institution, has been appointed secretary of the central petroleum committee of the National Research Council, which acts as adviser of the American Petroleum Institute in expending the funds for fundamental research on petroleum donated by Mr. John D. Rockefeller and the Universal Oil Products Company.

THE following officers were elected at the annual general meeting of the Geological Society of London, held on February 17: *President,* Professor J. W. Gregory; *vice-presidents,* Dr. F. A. Bather, Professor E. J. Garwood, Dr. E. Greenly and Mr. H. W. Monckton; *secretaries,* Mr. W. Campbell Smith and Dr. J. A. Douglas; *foreign secretary,* Sir Arthur Smith Woodward; *treasurer,* Mr. R. S. Herries.

M. MANGIN, director of the National Museum of Natural History, Paris, has been elected vice-president of the French Academy of Sciences to take the place of the late M. Henneguy.

THE Chicago Academy of Sciences has appointed Mr. Alfred M. Bailey as director. He was recently assistant on the Abyssinian expedition of the Field Museum, Chicago, and has been actively engaged in museum and field work during the past ten years.

WALLACE H. CAROTHERS has resigned his instructorship at Harvard University to accept a position with the E. I. du Pont de Nemours and Company, where he will engage in fundamental research in organic chemistry at the experimental station, Wilmington, Del.

PROFESSOR N. H. FURMAN, of Princeton University, has resumed his duties after a year's leave of absence,

during which he visited university and research laboratories and chemical plants in England, France, Germany and Austria.

HUGH B. FREEMAN returned from Chile on March 10, where he has been director of the Mt. Montezuma solar radiation station of the Smithsonian Institution for the past three years. M. Keith Baughman sailed for Chile on March 15 to take up the duties of assistant to Mr. Zodtner, the present director of the Mt. Montezuma station. Mr. Baughman expects to remain in Chile three years.

DR. C. E. MYERS, professor of plant breeding at the Pennsylvania State College and Agricultural Experiment Station, will be on sabbatical leave from April 1 to August 1. During this time he will tour the South Atlantic, Gulf, Western and Northern States. He will visit a number of the agricultural experiment stations and educational institutions and also some of the leading trucking and seed-producing sections.

CHESTER WASHBURNE, geologist, of New York, returned from Venezuela in March, and has since departed for São Paulo, Brazil.

DR. CHRISTIAN POULSEN, curator of paleontology at the Mineralogical Museum, Copenhagen, has returned to Washington for three months' research work on the U. S. National Museum's early Paleozoic invertebrate fossils in connection with his studies on these same faunas from Greenland.

DR. KARL BÜHLER, of the University of Vienna, who was visiting professor of psychology at the Johns Hopkins University during the first semester, is lecturing at Harvard University during the second semester.

SIR HUMPHRY ROLLESTON, Regius professor of physics at the University of Cambridge, will be in residence at the Peter Bent Brigham Hospital, Boston, for the week beginning March 25, as the fourteenth physician-in-chief, *pro tempore*, in charge of the medical service of Dr. Henry A. Christian, Hersey professor of the theory and practice of physics at Harvard University and physician-in-chief of the Peter Bent Brigham Hospital.

PROFESSOR W. E. BRAGG, of the University of Leeds, gave a lecture at the Rockefeller Institute for Medical Research on March 19 on "The Scattering of X-rays by Atoms."

DR. E. J. LONDON, director of physiology in the University of Leningrad, will deliver the sixth Harvey Society lecture at the New York Academy of Medicine on Friday evening, April 13. His subject will be "Experimental Fistulae of Blood Vessels."

DR. SIMON FLEXNER, director of the Rockefeller Institute of Medical Research, who has been chosen by the Association of American Physicians as the lecturer of the Kober Foundation for 1928, will deliver a lecture on "Obvious and Obscure Infections of the Central Nervous System" at Georgetown University.

DR. G. H. PARKER, professor of zoology and director of the zoological laboratory at Harvard University, will give a course of lectures in the graduate school of the Ohio State University from April 9 to 20. The course will consist of six lectures on organic evolution and four lectures on the animal mind.

ON March 17, Dr. C. E. Kenneth Mees, director of the Research Laboratory of the Eastman Kodak Company, Rochester, delivered an address to the Royal Canadian Institute, on the subject "The Formation of a Photographic Image."

DR. CORNELIUS C. WHOLEY delivered an address on "The Nature of Multiple Personality" before the Sigma Xi alumni association of the University of Pittsburgh on March 15. Moving pictures of a person exhibiting multiple personality were shown.

DR. C. DAVISSON, of the Bell Telephone Laboratories, New York, will address the Philosophical Society of Washington, March 31, on "Reflection and Diffraction of Electrons by a Crystal of Nickel."

DR. JEROME ALEXANDER, consulting chemist and chemical engineer of New York, recently lectured on colloid chemistry before the Baltimore section of the American Chemical Society, the Brooklyn Engineers Club and the New York Microscopical Society.

PROFESSOR EDWIN C. KEMBLE, of the Jefferson Physical Laboratory at Harvard University, addressed the Franklin Institute on March 29, when he spoke on "Recent Progress in the Interpretation of Molecular Spectra."

WILLIAM F. M. GOSS, formerly professor of railway engineering and dean of the college of engineering at the University of Illinois, died on March 23 in his sixty-ninth year.

PROFESSOR GAETANO LANZA, emeritus professor of theoretical and applied mechanics at the Massachusetts Institute of Technology, died on March 21, at the age of seventy-nine years.

DR. JOHN P. MUNSON, head of the department of biology at the Washington State Teachers College, died on February 27, aged sixty-eight years.

THE death occurred on March 4, at the age of seventy-five years, of Sir Aubrey Strahan, F.R.S., lately director of the Geological Survey of Great

Britain, and of the Museum of Practical Geology, London.

THE death is announced of Dr. E. J. Lesser, of Mannheim, Germany, known for his work on the carbohydrates, and of Dr. Theodore Curtius, of the University of Heidelberg, author of publications on the hydrazins.

THE sixth annual meeting of the Virginia Academy of Science will be held on May 4 and 5 at the College of William and Mary. A new section, that of geology, is to be organized at this meeting. Other sections of the academy are: astronomy, mathematics and physics, biology, zoology, chemistry, psychology and education and geology. Donald W. Davis, president of the College of William and Mary, is president of the academy.

A NATIONAL meeting on oil and gas power is being planned for June 14, 15 and 16, to be held at Pennsylvania State College. In connection with the meeting will be an exhibition—the first of its kind—of oil and gas engines, parts and accessories. It will be located in the new mechanical laboratory of the college, which is a well-lighted building with 20,000 square feet of floor space. The college is not only providing exhibition space free of charge, but is also supplying light, power, steam and compressed air in limited amount for the use of exhibitors. The technical program calls for a number of sessions on subjects of vital interest to this field of engineering. Such subjects as power economics, fuel, oil specifications, research and specialization in engine manufacturing will be discussed by prominent engineers and executives in the industry. The meeting is held jointly by the oil and gas power division of the American Society of Mechanical Engineers and the Pennsylvania State College.

IN connection with the recent celebration of the twenty-fifth anniversary of the founding of the University of Porto Rico, plans were discussed for the establishment of a school of tropical agriculture. The possibilities of founding a joint school with Cornell University have been considered. Dr. Livingston Farrand, president of Cornell University, who attended the anniversary celebration, is reported to have expressed his approval of the project and has outlined the details of the institution and its requirements, financial as well as scientific and physical, stating that Cornell would need to provide at least $1,000,000 in endowment to carry its share of the burden of the new school. A graduate school of tropical agriculture, Dr. Farrand said, would do more to increase productivity in the tropics and spread prosperity and make better living conditions in backward areas than any one other institution.

THE U. S. Coast and Geodetic Survey will in a short time put into operation at its observatory at Cheltenham, Md., the new seismometer recently developed by Dr. Frank Wenner, of the U. S. Bureau of Standards. This will be its first test at a seismological observatory. It has been operated by Dr. Wenner at the bureau during a period of four months past, during which earthquakes occurring at various parts of the earth have been recorded in a very satisfactory manner. This instrument differs in principle from others as yet in operation in this country in that the shock transmitted by the earth to the instrument is recorded not directly but through a galvanometer. This makes it possible, if desired, to place the instrument in a very small building, or in a cave if necessary, and then have the recording at a convenient building elsewhere.

THE United States government has taken up its option on 22,500 acres of forest land in the Waterville Gap of the White Mountains of New Hampshire. This virtually completes the final step in adding this area to the already extensive forest reservation in that section. With this purchase the government has a total area of nearly 750 square miles of public forest in this part of the White Mountains, which is considered one of the finest scenic sections of New England. The purchase was made at a price of $1,050,000, and became possible through adoption of the McNary-Woodruff bill, which completed its passage through Congress March 14 carrying a $1,000,000 appropriation for the purpose.

A CONFERENCE on racial differences was held in Washington on February 25 and 26 under the auspices of the division of anthropology and psychology of the National Research Council, and the committee on problems and policies of the Social Science Research Council. According to *Eugenical News* the conference was called to consider the coordination and facilitation of research on problems of racial differences and racial changes; such problems as occur in connection with the Negro and the immigrant in relation to Whites and stocks of earlier introduction. The subject was opened by 20 minute addresses by Drs. Fay-Cooper Cole, T. Wingate Todd, Franz Boas, W. I. Thomas, M. J. Herskovits, Joseph Peterson, Thos. Woofter, Jr., and Raymond Pearl.

UNIVERSITY AND EDUCATIONAL NOTES

NEW endowment gifts for the University of Chicago, totaling $208,250, have been announced by President Max Mason. They include $50,000 for scholarships and fellowships in archeology from the estate of

E. L. Ryerson, $50,000 for general endowment from J. J. Dau, of Chicago, $25,000 without limitation as to its use from Edward L. Swift and a number of smaller gifts.

A TOTAL of $96,245 has been received by New York University through gifts and bequests in the last two months. These include the following: From the estate of Margaret Olivia Sage, the university received $45,000; the Nicholas Foundation, Inc., made an additional gift of $23,600 for the William H. Nichols chemistry building fund, and anonymous, through Professor George David Stewart, $10,000 to be used for instruction in surgery in the medical college.

IN recognition of his investigations and experiments on plants, John H. Schaffner, for many years professor of botany and formerly head of the department of botany of the Ohio State University, has been promoted to the rank of research professor of botany.

PROFESSOR GEORGE W. GORRELL has been made head of the department of mathematics at the University of Denver.

DR. BRET RATNER has been appointed clinical professor of pediatrics and lecturer in immunology at New York University and Bellevue Hospital Medical College.

DR. CECIL V. KING, formerly instructor at Columbia University, has joined the staff at Washington Square College of New York University as assistant professor of chemistry.

PROFESSOR WATSON BARTEMUS SELVAGE has been appointed associate professor of education and psychology in Washington and Lee University.

G. ALLEN MAIL has been appointed assistant entomologist at Montana State College, University of Montana, Bozeman, for one year beginning on April 1 and will assist in teaching and conducting mosquito studies in northern Montana.

DR. R. K. BUTCHART, lecturer in mathematics in the University of St. Andrews (University College, Dundee), has been appointed to the chair of mathematics at Raffles College, Singapore.

DR. CHAMPY has been nominated professor of histology in the Paris faculty of medicine in succession to the late Professor Prenant.

DISCUSSION AND CORRESPONDENCE

SCIENCE AND SECRETARIES

THE proposed transfer of the geodetic work of the U. S. Coast and Geodetic Survey to the U. S. Geological Survey, for which provision is made in the bills now before both houses of Congress as noted in SCIENCE for January 13 and as discussed by Dr. Geo. Otis Smith in the number for January 20, involves a principle quite apart from the merits of the proposed administrative change. It is one which should interest all scientists who recognize the very important rôle played by the bureaus of the government in promoting or retarding scientific research.

The question is who should pass upon the conditions affecting the efficiency of research. Are the administrative secretaries in charge of departments competent to do so? It would not be difficult to cite evidence that they commonly are not. Many of them demonstrate abilities of a high order as administrators, but they themselves would disclaim the omniscience requisite to understand the workings of all the scientific bureaus.

The advisers of our secretaries are the heads of the individual bureaus and they naturally have their individual points of view. They are specialists, whose purpose is intensified and narrowed by the responsibility for the development of the work intrusted to each of them separately. They are worthy of all respect, but they can not be credited with a disinterested judgment regarding the relative abilities of their own organization or another's to carry out a particular scientific task.

In any proposal for reorganization of administrative relations two bureaus are commonly involved and often two departments, as in the present case. The two secretaries may agree, but the bureau chiefs may probably differ, as the heads of the respective surveys actually do. It is evident that there is need of independent, unbiased, adequately informed opinion as to the effects of any such transfer upon the efficiency of the research in progress.

The National Academy of Science is by law the adviser of the Government in scientific quesions. It comprises in its membership specialists in all branches of science. Among them are men whose judgment would command the respect of their colleagues at home and abroad and also that of their fellow countrymen who take an intelligent interest in the service our great government bureaus render the people.

Scientists may reasonably claim that research shall be organized according to the recommendations of those most competent to judge its needs and that changes in administration of our government bureaus, where they affect scientific activities shall be referred to the National Academy of Science for an expression of opinion by competent judges before they are made on administrative grounds.

At the Cleveland meeting of the Geological Society of America resolutions were passed recommending that the proposed transfer of the geodetic and seismo-

logic work be referred to the National Academy. Should that be done, as we may hope it will be, a broader proposition will be presented than that which has so far been discussed. The administrative question relates to the economy and convenience of executing primary triangulation in one or another connection. The scientific problems involve the ultimate objects of the triangulation. Will the astronomical and geophysical researches in geodesy be promoted by the change? Will the mathematical-physical investigations pertinent to seismology be advanced? Those are the real questions. And we should not forget that the reputation for work of superior accuracy and penetration which the United States has won during half a century of geodetic work presents a standard not easy to maintain in reorganization; nor that the seismologic studies have as their ultimate purpose the task of educating the American people to a better understanding of earthquakes and to better methods of protecting themselves from disasters such as we have hitherto not escaped. The questions are much broader and of more far reaching significance than the estimated attainment of economy of administration.

BAILEY WILLIS

STANFORD UNIVERSITY

RE SPECIATION WITHOUT CLIMATIC CHANGE OR GEOGRAPHIC ISOLATION

IT is an hypothesis rather generally held, and favored by a certain amount of evidence that speciation is largely dependent on changes of environment. A species moves from its center of abundance into diverse peripheral environments which change it somewhat both in structure and habits. Races are formed which are potential species, and become species by chance or other isolation. A study of races shows that such a process is in fact going forward.

There is per contrast little evidence of speciation in a single uniform circumscribed geographic locality. Nevertheless, certain considerations point to a probability that speciation does take place without environmental change and within the confines of a given locality.

We may conceive that a successful species becomes abundant and quickly reaches its saturation point within its range. Within that range there is, however, one outlet whereby it may still further increase, namely, by specializing in two directions. In due time groups of individuals may arise with such divergent habit tendencies. Slowly to be sure, and in the face of cross-breeding, they would diverge ecologically or physiologically up to that point where sufficient fundamental difference is attained to itself furnish a certain amount of isolation. Then the split might come so quickly, the intergradation period have so short a duration in time as to be seldom noticed. There is evidence, mostly circumstantial to be sure, that such speciation does occur and is of considerable importance. It may well be of primary evolutionary importance, for it is not the peculiar isolated environments most favorable for the differentiation of races which give rise to the successful types which spread and become dominant. It is rather the large, uniform, favorable areas which evolve a strong fauna, hard for weaker forms to penetrate, but whence dominant species spread and radiate to the four corners of the earth. The strong fauna of any given moment has probably corresponded to a distribution center of passing time, and it is from such distribution centers that the animals of succeeding epochs seem to be derived. Correlation of the zoogeographical "fauna" with the paleontological "distribution center" will, in the writer's opinion, clarify the path of both sciences.

It will illustrate the above hypothesis of speciation to cite a few instances where it may have pertained. The pilot-fish (*Naucrates*) seems to be a specialized derivative of the genus *Seriola*. Probably all species of this genus as young fishes have the habit, to a greater or less degree of lurking under some "hover," such as a bit of drift-wood, and of following larger fishes. The pilot-fish does so throughout life, and its generic peculiarities are doubtless correlated with this difference. Furthermore it is logical to suppose that habit and correlated physiological differences in this case preceded structural adaptation, and one may easily conceive the initial habit split to have occurred within some such species as the banded rudderfish, *Seriola zonata*.

Take another case, the well-watered Alleghany mountain region is a center of abundance and variety for salamanders of the genus *Desmognathus*. Various more or less separate or intergrading forms occur here living more or less in and out of the water, and with them is found the more exclusively aquatic derivative genus *Leurognathus* (Dunn, 1926, Salamanders of the family Plethodontidae). It certainly seems as if *Leurognathus* had split off as an ecological adaptation in this optimum region of *Desmognathus* abundance, descendent of those *Desmognathus* with the greatest aquatic tendency.

Among birds, the writer has earlier suggested (1919, *Auk*, p. 225–228) that the numerous related species of Warblers of the genus *Dendroica*, nesting together in the Canadian forest, can be more rationally explained as divergence in one locality to take advantage of special habit niches, than as each the result of past geographic isolation, implying later gathering

together and fitting the various forms into the single uniform environment where they now occur.

Again take the case of the flying squirrels (*Glaucomys*, etc.): presumably they arose in a region where there were many arboreal squirrels, descendent from those which did the most jumping, rather than isolated, and as a response to some peculiar environment which made it imperative for squirrels to fly.

J. T. NICHOLS

THE AMERICAN MUSEUM
OF NATURAL HISTORY

WEIGHT AND HUMIDITY

THE article entitled "Weight and Temperature" by Dr. P. G. Nutting, which appeared in SCIENCE of December 30, 1927, states that "a consistent difference of 1.2 mg. was found" between the weight of a lump of gold and the weight of the same lump after it had been rolled into a sheet, and that this difference was "probably due to adsorbed moisture." As there is considerable lack of agreement[1] in the literature regarding the influence of humidity upon weight, it seems desirable to publish the results of an investigation conducted some time ago on this subject.

Since the density of water vapor is less than that of air the hygroscopic condition of the atmosphere may be ascertained by comparing its density with that of dry air. If, therefore, a bulb containing dry air which is in communication with an open vessel containing the drying agent is counterpoised by a pointer, after the fashion of a micro-balance, it is possible to arrange the period of the instrument so that ample sensitiveness for hygrometric work may be assured. This method was tried, using a glass bulb. It was found, however, that the deflections of the instrument were much greater for certain changes in humidity than had been anticipated. An investigation was therefore started to determine whether or not the effect was due to the adsorption of water vapor. The materials used were glass, aluminium, hard rubber, bakelite and quartz. The glass was in the form of a bulb of surface area about 200 sq. cm., the aluminium, hard rubber and bakelite were in sheets of approximately 500 sq. cm. surface, while for the quartz a cup of surface area about 300 sq. cm. was used.

The object to be investigated was placed on the scale-pan of a highly sensitive Becker balance and counterpoised with standard weights. Inside of the balance case were placed two thermometers and two flat dishes which were filled with sulphuric acid of the proper density to assure certain relative humidities inside the balance case. Readings were taken every morning and the acid changed each time. Thus the weight of the object could be determined at relative humidities varying from 10 per cent. to 90 per cent. Care was taken to keep the temperature constant, and the balance was never allowed to oscillate nor was it ever disturbed in any way in the course of the investigation.

It was found that the glass bulb adsorbed 0.5 mg. after having been washed in boiling water and dried over a flame for one hour and 2.3 mg. after having been washed and then dried in air.[2] The quartz cup gained in excess of 1 mg. The gain in weight of the aluminium was about half as much per square centimeter as for quartz. Hard rubber and bakelite were found to be immensely more hygroscopic than these. *But in all cases the amount of water vapor adsorbed varied with the humidity.* Furthermore it was found that the water vapor is adsorbed much more quickly than it is given up. A dry object will adsorb its definite amount of water vapor in an atmosphere of a definite relative humidity in less than two hours; this same object may require a day to lose its water vapor if placed near concentrated sulphuric acid. It was obvious, then, that due to the adsorption of water vapor and this "hysteresis" effect neither the hygrometer mentioned above nor one based on the hygroscopicity of materials is feasible. A successful, continuously indicating, density-difference hygrometer which avoids these disturbing effects was later constructed.[3]

In conclusion we may say that the apparent weight of an object of relatively large surface varies appreciably with humidity and that this fact, as well as the "hysteresis" effect mentioned, should be taken into account in accurate weighings.

ARNOLD ROMBERG
L. W. BLAU

PHYSICAL LABORATORY,
UNIVERSITY OF TEXAS

LEPIDOPTERA OF NEW YORK

To users of the "List of the Insects of New York" (Cornell Memoir 101): I much regret that in the circumstances of the compilation of the Lepidoptera records of this list it was not possible to publish many of the authorities for collection or determination of the material gathered before 1916. These data are preserved, however, in our files at Cornell University.

I also regret, although I can not accept personal

[1] (a) Warburg and Ihmori, *Ann.*, 27, p. 481, 1886. (b) Trouton, *Proc. Roy. Soc.*, A, 79, p. 383. (c) Kuhn, *Deutsche Chemikerzeitung*, 34, p. 1097, 1910. (d) Scheringa, *Pharm. Weekblad*, 56, p. 94, 1919. (e) Metzger, *Glueckauf*, 60, pp. 39–44, 54–60, 94–97, 112–116, 1924.

[2] *Loc.* 1 (a).

[3] *J. Opt. Soc. Am. & Rev. Sc. Instr.*, 13, p. 717, 1926.

blame for them, many obscurities in the credits for records received later, and some errors, resulting from the innumerable changes made in the editorial office of the New York State College of Agriculture. They were made in violation of a definite agreement, and they refused to rectify them in proof. I may say that the proof of the "Lepidoptera of New York" (Memoir 68) had received similar treatment, and that the agreement was made in that connection and reiterated in later letters.

WM. T. M. FORBES

CORNELL UNIVERSITY

THE EASTLAND HORNED "TOAD"

MUCH attention has been attracted recently to a Horned "Toad" (*Phrynosoma cornutum*) which is alleged to have been placed in the corner stone of the Eastland County courthouse, Eastland, Texas, in the year 1897. The animal, it is claimed, remained entombed in the granite corner stone until February 18, 1928, a period of thirty-one years. On the latter date it is said to have been removed from the stone alive, before a large crowd of spectators which had gathered for the occasion.

On February 22, 1928, the writer had the opportunity to go to Eastland and make an examination of the external features of the animal in question. It appeared to be a perfectly normal specimen which had undergone winter hibernation. It was probably an old one for the horns about the head region were considerably worn and the right hind leg had been broken but was healed. Otherwise it appeared no different from a normal Horned "Toad" at this season of the year.

WILLIS G. HEWATT

TEXAS CHRISTIAN UNIVERSITY

THE BRASSO FOSSILIFEROUS MIOCENE OF TRINIDAD, WEST INDIES

To avoid any possible future confusion, it seems well to note that the Brasso Miocene clay and Brasso conglomerate described by Mr. Gerald Waring, in his Geology of Trinidad, Johns Hopkins Studies in Geology No. 7, pages 69, 71, and Legend of Map, 1926, are entirely distinct from the fossiliferous Brasso Miocene of my report, Miocene of Trinidad, *Bulletin of American Paleontology*, No. 42, pages 10, 16, 1925. The black clays and conglomerates mentioned by Mr. Waring *underlie* the Manzanilla formation. The fossiliferous beds, typical at Brasso Junction, mentioned in my memoir, *overlie* the Manzanilla, and carry a fauna of Middle Miocene Age, related to the Gurabo and Bowden faunas.

CARLOTTA J. MAURY

YONKERS, N. Y.

SCIENTIFIC BOOKS

THE CEPHALASPIDAE

PALEONTOLOGISTS the world over may justly feel a thrill of pride that one of their number, Erik A: Son Stensiö:, has produced such a splendid publication containing important, new and much needed information on the earliest known vertebrates, those curious mailed Silurian and Devonian chordates, which we have been calling Ostracoderms.[1] The most striking feature is the abundance of data, mostly new, on the nervous and vascular systems, the special sense organs, the finer anatomy of the skeleton, and suggestions as to habits of life. After examining the work one feels that he has been studying a treatise on modern fishes. The author has combined with the usual paleontological methods, those of the anatomical laboratory. His needle dissections under a binocular, the object immersed in a non-refracting medium; his use of the wax-plate method of serial section, invented by Sollas for fossils, his painstaking correlations with refractory material, form welcome and highly useful methods in Paleontology.

Following the first expedition fitted out by Prince Albert I, of Monaco, in 1906, there have been eleven expeditions to Spitsbergen up to 1925. The remains of the Cephalaspidae studied by Stensiö:, 105 specimens in all, were assembled from the collections of these Norwegian expeditions. This forms one of the most important discoveries of fossil vertebrates ever made.

The historical account, covering sixteen pages, itself an undertaking of no small magnitude, reviews the published accounts of the geological occurrence, taxonomy and anatomy of forms known. This is followed by a discussion of the anatomy of the Spitsbergen species; 205 pages being devoted to this phase of the work. Description of the genera and species occupies fifty-one pages. There are five genera, four of which are new, and twenty-four species, *all* new. A brief discussion of the Trematapidae, and the general relations of other groups of primitive chordates to the *Cephalaspidae*, concludes the text. A reasonable bibliography of ten pages makes no pretense at completeness, but the interested student can safely use these references as a guide to the field. Personally, I should like the references given to be more exact, and to refer specifically to the part of the work which discusses the Cephalaspidae. It would lighten the labor of future workers. The second volume of

[1] "The Downtonian and Devonian Vertebrates of Spitsbergen." Two volumes octavo, pp. 1–391, 1 map, 103 text-figures, 112 plates. Det Norske Videnskaps-Akademi I Oslo. Resultater av de Norske Statsunderstøttede Spitsbergenekspeditioner. Nr. 12, 1927.

112 plates, photographic in large part, leaves little to be desired. One may study these reproductions with a lens or reading glass with great profit. The descriptions of the plates are printed opposite the pictures, and they are given in full in each case—a praiseworthy feature.

Neurologists, especially those dealing with the brain and cranial nerves of fishes, will profit greatly by examining the author's discussion of the brain and adnexa of *Cephalaspis*. Stensiö tells us that he took two months to dissect the endocranial parts shown on plates 49 and 50. He finds the brain to be that of a cyclostome and on this basis as well as others, he says that the creatures we call Ostracoderms are cyclostomes. The differentiation of marginal electric fields will be a surprise, but while he has not defined the electroplaxes, yet it seems reasonable to agree that this neuro-muscular specialization may have taken place as early as the Silurian (Downtonian).

It has taken a long time to extricate the Ostracoderms from the eurypterids, from the arachnoids, from the annelids, but we feel that Stensiö has opened the way for us to believe, with him, that these early Paleozoic fishes are cyclostomes. The importance of this is very great, and if generally accepted will lead to still greater correlations. Our author says:

> It is clear now that the Ostracodermi, though very lowly organized, are true craniate vertebrates which have nothing whatever to do either with the Arthropoda or with the Annelida.
>
> The investigations carried out in this work have thus thrown light not only on the organization of the *Cephalaspidae*, but also on the Ostracodermi as a whole: and we have even been able to establish that the Ostracoderms still persist in the recent *Petromyzontia* and *Myxinoidea*, though they play a much less important part than during the early palaeozoic time.

Those who think the field of vertebrate paleontology is largely exhausted will receive a new stimulus in examining this work of Stensiö. It stirs our ambition to do further work to advance our knowledge of the vertebrates of ancient times. No more worthy scientific piece of work has appeared for decades and Stensiö is to be congratulated on the appearance of this, the most monumental study he has yet made.

ROY L. MOODIE

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A UNIVERSAL MUSCLE LEVER

THE problem of providing a universal muscle lever for the use of students taking their first course in experimental physiology led to the construction of the apparatus here described. The requirements to be filled are not met, to the writer's knowledge, by any instrument on the market—a lever with well insulated "head," so arranged as to allow free adjustment in the horizontal plane, a strong after-loading screw, and, above all, an instrument constructed so sturdily as to withstand rough usage.

A number of attempts were made to modify other muscle levers to suit our requirements but without satisfactory results. Finally, with the assistance of a pattern-maker, a model somewhat like the one sketched in Figure 2 was constructed from soft pine and a few brass castings made. When finished and assembled, the instruments were found to be quite satsifactory.

This instrument consists of a handle, a lever holder or head, and a lever. The handle is made from a 6-inch length of 3/8 inch round bakelite rod which is slipped into the tubular end of a switchboard lug having an opening of that diameter. A hole is then drilled through the lug and the bakelite rod and the rod riveted into place. The flattened portion of the lug is centered and drilled to allow the passage of a number six machine screw.

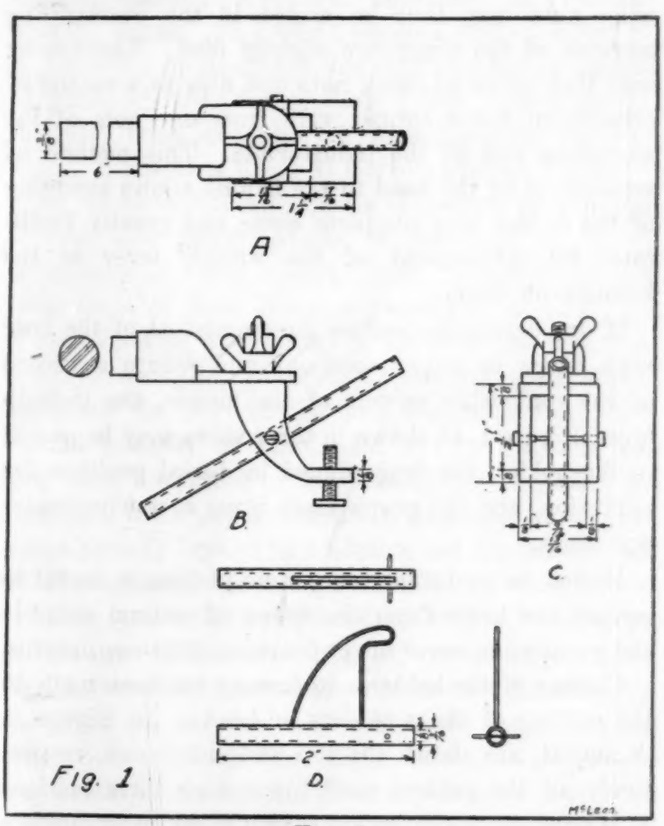

FIG. 1

The holder, the distinctive part of the apparatus, is made according to the dimensions given in Figure 1, A, B, C, showing top, side, and end views, respectively. This holder or head consists of a table, with dimensions as shown in the figure, from two parallel sides

of which project downward and parallel to each other, two crescent shaped arms. Across the distal end of these arms is a bar, parallel to the table and 1/8 inch thick in order to support a 6/32 knurled head, brass, machine screw, the after-loading screw. Through the middle portion of the parallel crescents are drilled holes to receive 2-56 cup-pointed machine screws. These cups receive the pointed ends of the lever axle. The lever is made from a 3-inch length of 5/32 inch, outside diameter, brass tubing, which is drilled transversely at its middle point and a small brad soldered in place. Both ends of the brad are then sharpened to make an axle of sufficient length to fit the adjustment limits of the cup-pointed screws. The writing lever is made from a six to eight-inch length of split bamboo rod, about one eighth inch in diameter, and tipped with a small piece of thin brass shim.

The holder is firmly attached to the handle by means of a 6/32 brass machine screw which passes through the center of the table of the holder and whose head is countersunk in and soldered to the lower surface of the table. When assembled, this screw is passed through the hole in the handle and two wing nuts are placed thereon. It has been found that two wing nuts may thus be nested if the overlapping margins of the wings are slightly filed. These wing nuts then serve as check nuts and also as a means of attachment for a copper wire from one pole of the secondary coil of the inductorium. This method of attachment of the head to the handle allows swinging of the holder in a complete circle and greatly facilitates the adjustment of the writing lever to the kymograph drum.

If one desires to perfuse the circulation of the frog with drugs or sugar solutions and secure a record of the contractile powers of the muscle, the kick-up lever, Figure 1, D, shown in three views may be placed in the holder, the frog pinned in dorsal position for perfusion, and the graph made upon a slowly revolving drum.

Nickel- or preferably chromium-plating is useful to protect the brass from the action of sodium chloride and greatly improves the appearance of the apparatus.

Casting of the holders: Reference has been made to the casting of these holders or heads. In Figure 2, A and B, are shown the top and side views, respectively, of the pattern used for casting three holders. It is much more convenient to cast eight or ten holders at a time and partially finish them upon a shaper or milling machine than to cast a lesser number. After partially finishing the castings, they are sawed apart with a machine hack-saw and finished by hand. In all probability jigs could be made which would facilitate this work; but for the number of holders finished, the trouble involved in making jigs was not considered necessary.

In September, 1926, about eighteen of these muscle

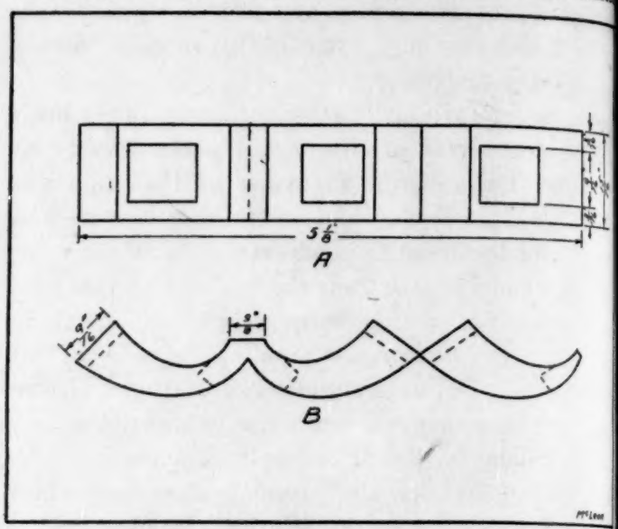

FIG. 2

levers were made and since that time, they have been used by over 600 students working in groups. These levers have been used for recording a simple muscle twitch, for demonstrating the maximum lifting power of a muscle, as well as numerous other experiments, and have given no trouble whatever.

Although this lever is as yet a relatively crude product, finished by hand, it has the following advantages:

1. An insulating handle or support rod;
2. An adjustable head with after-loading screw;
3. It may be used to record the responses of muscles reacting in either the vertical or horizontal plane;
4. It is sufficiently rugged that it will withstand the rough usage of college sophomores who are more accustomed to the manipulation of five-year-old Fords than to the delicate equipment of a physiological laboratory.

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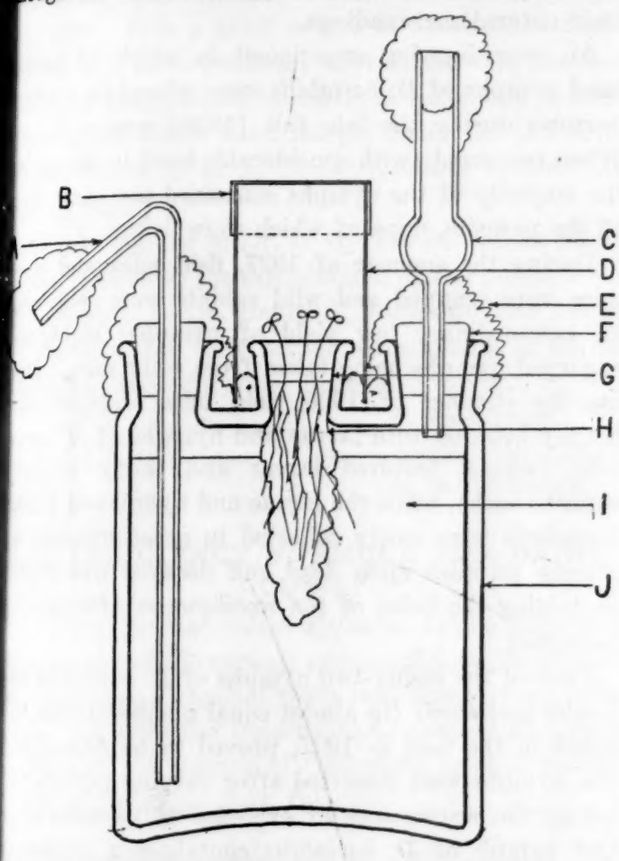
METHOD FOR GROWING SMALL-SEEDED PLANTS UNDER STERILE CONDITIONS

THE accompanying figure diagrammatically shows the principal details of a method now being used at the Massachusetts Agricultural Experiment Station for growing tobacco plants under sterile conditions.

In the middle opening of a 3-neck Wolff bottle is placed a plug (H) of absorbent cotton which serves both as a substratum for the plantlet and a wick for the nutrient solution (I). Before seeding, the entire apparatus as shown, with the exception of the layer of nutrient agar (G) and the celluloid cover (D), is set up and sterilized under steam pressure. Then, under aseptic conditions, the thin layer of nutrient

gar is added, the seed planted in it, and the cover ut on. A glass cover could under some circumances be advantageously substituted for the cellulid cover.

Sterile non-absorbent cotton is used for protecting xposed openings. After the plantlets grow large nough to fill the cover, it may be removed, all but



one plant removed and sterile cotton worked around it, if it be desired to grow it further.

This method was especially worked out for tobacco, but seems applicable to any small-seeded plant whose plantlet is small, slow-growing and difficult to transplant under aseptic conditions. It differs from other proposed methods in that (1) the plantlet remains in the original substratum and (2) that a layer of nutrient agar is introduced to indicate asepticism.

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SPECIAL ARTICLES

THE OVERWINTERING IN MASSACHUSETTS OF IXODIPHAGUS CAUCURTEI

THE purpose of this communication is to record the overwintering of *Ixodiphagus caucurtei,* a hymenopterous chalcidian parasite of ticks, introduced upon the Island of Naushon for the control of *Dermacentor variabilis,* the common dog tick of Eastern Massachusetts.

This fly was discovered by Professor E. Brumpt in nymphs of *Ixodes ricinus* taken in the neighborhood of Paris (Chantilly and Fontainebleau). It was described by M. R. du Buysson in 1912 (*Archives de Parasitologie,* xv, p. 246). Its use for the control of ticks responsible for the transmission of diseases, including Rocky Mountain spotted fever, was proposed by Brumpt in 1913 in a short article "Utilisation des Insectes auxiliares entomophages dans la lutte contre les Insectes pathogénes" (*La Presse Médicale,* No. 36 du 3 Mai 1913). In this article Brumpt records the parasitization by this fly of the following species in addition to *Ixodes ricinus*:

Haemaphysalis concinna
Rhipicephalus sanguineus
Dermacentor andersoni

It is pertinent to recall in connection with this report early work of L. O. Howard. In 1907, he described and figured the first chalcid parasite of a tick and established the genus *Ixodiphagus* in his description of *Ixodiphagus texanus.* (*Ent. News,* xviii (1907), pp. 375–378). His specimens were obtained from nymphs of the rabbit tick *Haemaphysalis leporis-palustris,* Packard, collected in Jackson County, Texas. In 1908 (*Canadian Entomologist,* xl, p. 239–241) he described and figured another chalcid parasite, *Hunterellus hookeri* (tribe Ixodiphagini), obtained from nymphs of *Rhipicephalus texanus,* Banks, taken from a dog at Corpus Christi, Texas.

An unsuccessful attempt to introduce *Hunterellus hookeri* into South Africa is described by C. P. Lounsbury in 1908 (Rept. Govt. Entomologist for 1908, Cape of Good Hope, Appendix iv, p. 65.)

The Naushon experiment is probably the first adequately conducted attempt—apparently successful—involving the introduction and acclimatization of a chalcid parasite of ticks. Dr. S. B. Wolbach had long been interested in the possibilities suggested by Brumpt's brief paper, inasmuch as *Ixodiphagus caucurtei* already existed in a climate not too unlike that of certain Rocky Mountain spotted fever territories to preclude probability of acclimatization. The hope of ultimate utilization of the fly for control of the Rocky Mountain spotted fever ticks was the deciding factor in the decision to try first this method in an attempt to alleviate the heavy tick (*D. variabilis*) infestation of the privately owned island of Naushon, near Woods Hole, Massachusetts. Hence an altruistic spirit as well as a desire for relief from annoyance prompted the owners of the island in their financial support of this experiment. The Department of Pathology of the Harvard Medical School made necessary preparations, provided materials and equipment, and an assistant, Mr. Arthur G. King.

Professor Brumpt received the idea with great enthusiasm and gave permission for his assistant, Dr. F. Larrousse, to undertake the actual conduction of the experiment, which was begun in May, 1926, following the arrival of Dr. Larrousse in this country.

The fly was obtained from the Forest of Fontainebleau. A total of nine deer skins was examined in Professor Brumpt's laboratory between January 12th and March 23rd, 1925, for ticks. In all, 1,205 were collected, the following species being represented: *Ixodes ricinus, Dermacentor reticulatus, Haemaphysalis inermis, Haemaphysalis concinna.* There were 94 nymphs of *Ixodes ricinus,* one of which was parasitized with *Ixodiphagus caucurtei.* From the parasites which emerged from this nymph the strain was propagated in the laboratory.

Dr. Larrousse brought to this country parasitized nymphs of *Dermacentor reticulatus, Rhipicephalus sanguineus* as well as larvae, unparasitized nymphs and adults of both species.

Adults of two species of ticks (*Dermacentor variabilis* and *Rhipicephalus sanguineus*) were collected at Naushon and nymphs raised from these were parasitized in the laboratory of pathology of the Harvard Medical School.

Dermacentor variabilis proved to be easily parasitized by *Ixodiphagus caucurtei,* though difficult to rear in the laboratory as the larvae attached to guinea-pigs and rabbits in small numbers only. Later with Dr. Larrousse's discovery of a natural host of the larvae and nymphs of this species—the common field mouse, *Microtus pennsylvanicus pennsylvanicus,* the rearing and parasitization of nymphs was much facilitated in the field laboratory established at Naushon. Another species of tick, *Ixodes scapularis,* was found in great numbers upon the island and proved also to be easily parasitized by *Ixodiphagus caucurtei.* The normal host of the larvae and nymphs of this tick was found to be the white-footed wood-mouse, *Peromyscus leucopus,* but both larvae and nymphs readily attached to rabbits and guinea-pigs.

Other species of ticks found in smaller numbers upon the island were *Rhipicephalus sanguineus* and *Haemaphysalis leporis-palustris,* the latter found but once.

Experiment proved that nymphs of *Dermacentor variabilis* attached to rabbits become parasitized in the field by flies liberated at distances of 50 and 100 meters, no greater distances being tried in the experiment.

Three methods were used in introducing the parasites.

1. Large numbers of the flies were liberated in situations where nymphs of *Ixodes scapularis* were numerous and in other regions where *Dermacentor variabilis* abounded.

2. Parasitized nymphs of *Ixodes scapularis* were returned to their original situations, mouse holes, etc.

3. Domestic mice (*Mus domesticus*) and field mice (*Microtus pennsylvanicus pennsylvanicus*) with parasitized nymphs still attached were liberated amidst their natural surroundings.

An overwintering experiment in which 34 parasitized nymphs of *D. variabilis* were placed in artificial burrows during the late fall (1926) was a failure. When recovered (with considerable loss) in the spring the majority of the nymphs contained the adult form of the parasite, none of which were living.

During the summer of 1927, field mice and wood mice were trapped and wild rabbits were shot, with an extraordinary low yield of nymphs; eighty-two engorged nymphs being taken from sixty mice. During the summer of 1926, field mice trapped were heavily infested with larvae and nymphs of *D. variabilis* (several hundred larvae and thirty to forty nymphs each), while the larvae and nymphs of *Ixodes scapularis* were easily collected in great numbers by placing puppies upon dead and decayed tree trunks containing the holes of the wood-mouse (*Peromyscus leucopus*).

Four of the eighty-two nymphs of *D. variabilis* and *Ixodes scapularis* (in almost equal numbers) thus collected in the field in 1927, proved to be parasitized. The nymphs were dissected after varying periods following the appearance of evidence of parasitization. One nymph of *D. variabilis* contained a cluster of eggs with developed embryos of *Ixodiphagus caucurtei,* two contained full-grown larvae. One nymph of *Ixodes scapularis* was dissected after the lapse of ample time with failure of the fly to emerge; fully developed adults were found.

These results, though scanty, proved that *Ixodiphagus caucurtei* had survived a New England winter under natural conditions and had propagated itself. It would be perhaps premature to attribute the extraordinary reduction in ticks noticed in 1927 to the parasite alone. Quantitative methods of estimating the tick population were not employed. The difficulty of obtaining larvae and nymphs of *D. variabilis* and *I. scapularis* in 1927 has been noted above. A similar diminution in adult ticks was also noted. Whereas in July, 1926, the ticks, *D. variabilis* in particular, were so numerous that a brief walk through certain places always resulted in the collection of from 30 to 40 ticks upon one's clothing, in July, 1927 the same procedure would yield only an occasional tick, often none at all. Likewise the heavy infestation of domestic animals, cats, dogs, sheep and horses

annually experienced disappeared in 1927. This notable decrease of ticks on Naushon was in marked contrast to conditions on the adjacent mainland—Cape Cod, where ticks were unusually numerous at several different points, hence the influence of climatic conditions may be excluded.

Further observations will be made at Naushon during 1928. It is a great source of satisfaction that a similar and more elaborate experiment with the same strain of *Ixodiphagus caucurtei* is under way in Montana, in the Bitter Root Range, under the able direction of Professor R. A. Cooley (*Medical Sentinel*, December, 1927).

Thanks are due to Dr. L. O. Howard for his kindly offices relative to the introduction of the parasite into this country; to Dr. Henry S. Forbes and the owners of Naushon, for their actual participation in the experiment, hospitality and financial support.

F. LARROUSSE
ARTHUR G. KING
S. B. WOLBACH

AN EFFICIENCY FORMULA FOR DAIRY COWS

IN 1901 Jordan[1] called attention to the differences in efficiency of the various species of domestic animals as converters of animal feeds into human food materials. He gave the production of pounds of "edible solids" per 100 pounds of "digestible organic matter" in the ration as, in part, follows:

Animal and Product	Edible Solids
Cow, Milk	18.0
Hog, Carcass	15.6
Calf, Carcass	8.1
Fowl, Egg	5.1
Fowl, Carcass	4.2
Steer, Carcass	2.8
Sheep, Carcass	2.6

These figures still pass current as representing the efficiency of the animal producer. Jordan clearly pointed out that the figures given are average values and subject to considerable variation, according to various conditions of management, and as between individual members of the species.

With respect to milk production by the cow it is well known that the efficiency of production depends to a great extent upon the annual yield of milk. This note presents a formula for the estimation of a coefficient of efficiency based on the weight and annual yield of the cow. It is intended further to suggest the significance of milking capacity in the dairy cow from the standpoint of the future of the milk supply. Foods of animal origin are inherently expensive, and their consumption has always become more or less restricted with increasing population. Naturally, the more efficient the animal converter the less such restriction need apply. The significance of the efficient cow to the people at large may be better appreciated when we realize that about 45 per cent. of all animal foods consumed in the United States come from dairy cattle.[2]

The coefficient here proposed is essentially similar to the ratio of Jordan, but with this modification, that digestible nutrients[3] (D. N.) are substituted for his "edible solids" on the one side, and also for his "digestible organic matter" on the other side. Accordingly the coefficient of efficiency (C. E.) is 100 × (digestible nutrients in milk produced) ÷ (digestible nutrients in food consumed). How is this coefficient related to the annual milk yield and weight of the cow?

The digestible nutrients of the milk will vary with the quantity and quality of the milk. The richness of the milk may be disposed of by expressing the yield in terms of 4-per cent. (fat) milk by use of the formula,[4] F. C. M. = .4M + 15F, where F. C. M. is fat-corrected milk or 4-per cent. milk, M is the actual milk, and F is fat; all in pounds. One pound F. C. M. = .172 pounds of digestible nutrients; and, therefore (digestible nutrients in milk produced) = .172 F. C. M.

The remaining variable factor in the coefficient may be estimated from Haecker's[5] data. His maintenance standard is, Digestible nutrients for maintenance per year = 2.893 W, where W is live weight of the cow in pounds. His data show[6] that, Digestible nutrients for lactation = .327 F. C. M.

By substitution and a simple transformation we have the formula:

$$\text{C. E.} = 52.6\,\frac{\text{F. C. M.}}{\text{F. C. M.} + 8.847\ \text{W}}$$

[1] "The Feeding of Animals."

[2] Pearl, "The Nation's Food." This estimate is based on total calories and allows a small but proper credit for the beef and veal derived from dairy stock. Swine supply another forty per cent. It has been often stated, on the basis of the superior efficiency of the cow and hog, that they will be the surviving animals. From the standpoint of food consumption it might be better to say that they *are* the surviving animals.

[3] Protein + carbohydrates + fat × 2.25. It might be better to replace digestible nutrients by net energy if our knowledge of the properties of various feeds in this respect were adequate.

[4] *Bul.* 245, Ill. Agr. Exp. Sta.

[5] *Bul.* 140, Minn. Agr. Exp. Sta.

[6] *Bul.* ——, Ill. Agr. Exp. Sta. (in press).

The factor, 52.6, represents the percentage efficiency of the mammary gland itself. The fractional factor shows the proportion of this efficiency which is realized when the additional nutrients required for body maintenance are included. As an example, if the cow weighs 1,000 pounds and her annual yield is 8,847 pounds F. C. M., the maintenance and lactation requirements are equal, and one half of the potential efficiency of the mammary gland is realized by the whole organism; that is, C. E. = 26.3.

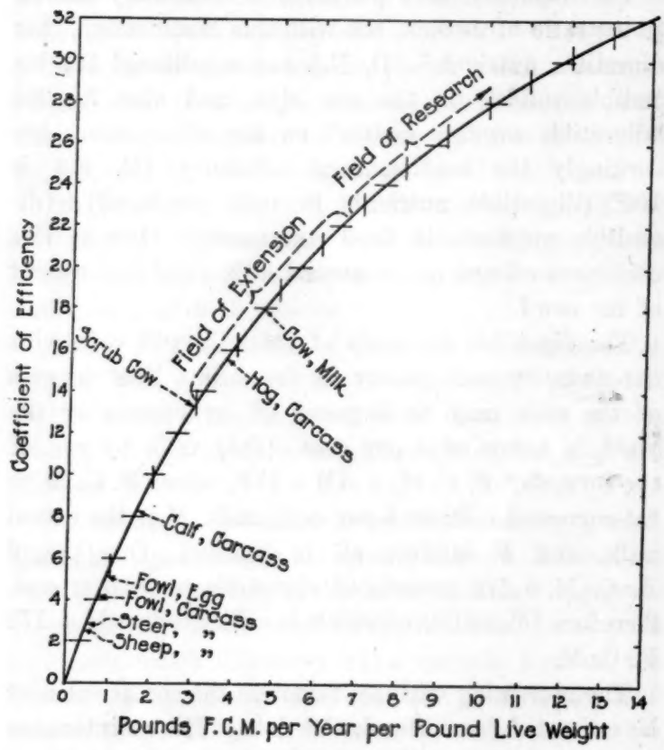

FIG. 1

EFFICIENCY CURVE OF THE COW IN MILK PRODUCTION

The arrows at the right indicate Jordan's average efficiency values for various species. The arrow at the left indicates the average efficiency of the unimproved cow. The first bracket denotes the improvement which may now be readily effected. The second bracket suggests the possibility of still further improvement through the efforts of the breeder and investigator.

Figure 1 illustrates the C. E. curve graphically for yields and weights up to 14,000 pounds F. C. M. per 1,000 pounds live weight. The efficiency values of Jordan, above quoted, are indicated by the arrows at the right of the curve, although they are not strictly comparable with the present formula. It will be noted that the sheep, the steer and the fowl compare in efficiency with a 1,000-pound cow producing 500 to 1,000 pounds F. C. M. per year.

Jordan's efficiency figure for the cow is considerably larger than may be expected of the unimproved animal, whose probable position is indicated by the arrow at the left of the C. E curve. But it is entirely feasible by present known methods of mating and feeding to create and maintain a stock superior in efficiency to Jordan's figure, say up to C. E. = 22 or 23. This may be designated the field of extension, in which so much productive work has been accomplished by the Smith-Lever or corresponding forces of the Land-Grant Colleges, and in which so much still remains to be accomplished. Beyond this there lies the promising field of research in nutrition and in genetics, in which we may possibly hope some day to realize an efficiency of say, C. E. = 30. This, however, is a difficult goal for, according to the formula, C. E. = 30 requires 11,744 pounds of 4-per cent. milk per year per 1,000 pounds live weight, a capacity quite beyond any present certainty of the industry.

Finally, as to the accuracy of the C. E. formula we may consider the very extensive and practical cross-breeding experiments of the Danes. The following figures, adapted from Frederiksen,[7] are the average yearly results for over 1,000 cows during a period of 10 years:

Breed of Cows	Red Danish	Crossbred	Jersey
Weight, lbs.	1021	913	796
Milk, lbs.	7934	6389	5018
Fat, per cent.	3.60	4.28	5.34
Fat, lbs.	286	273	268
F. C. M., lbs.	7458	6657	6027
D. N. in milk, lbs.	1283	1145	1037
D. N. in feed, lbs.	5388	4809	4347
Observed C. E.	23.8	23.8	23.9
Computed C. E.	23.8	23.8	24.3

The C. E. formula is in excellent agreement with these observed average results. As between individual cows we may expect some variability, and the formula may not be expected to apply to some of the advanced registry records of the dairy breeds in this country, where extravagant feeding and delayed breeding have been practiced. But under conservative practices of feeding and breeding (recurrence of conception) it should serve as an index of the relation between yield and efficiency for a given weight.

To determine the milk and fat yields of individual cows is now well recognized as advanced dairy practice. The present formula clearly shows that a record of the weight of the cow as well as her yield is necessary to afford a useful index of her efficiency. Since the weight of dairy cows varies from less than 500 pounds to more than a ton, the weight factor can not be ignored.

W. L. GAINES

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UNIVERSITY OF ILLINOIS

[7] Meddelels 2, Forsøgslaboratoriets Husdyrbrugsafdeling (Copenhagen).

SCIENCE NEWS

Science Service, Washington, D. C.

ELECTRICITY FROM THE AIR

ELECTRICITY of nearly two million volts, capable of jumping gaps of nearly 15 feet, has been obtained from the air by Drs. A. Brasch, F. Lange and C. Urban, three members of the staff of the Physical Institute of the University of Berlin.

Mount Generoso, in Switzerland, near Lugano, was the scene of these experiments and the experiments will soon be resumed. This mountain is noted for the frequency of electrical storms upon it, and also it has the advantage of being easily accessible.

It was found impossible to make use of kites for the purpose of collecting the atmospheric electricity, because use was made of a wide-meshed wire net having an area of several hundred square yards. It was out of the question, they found, to suspend this from kites or balloons, because such means would be particularly undependable during a storm, when the experiments were made.

In order to get the net as far as possible above the earth, they hung it on a cable between two mountain peaks. The span was about 1,800 feet, and the height of the net above the ground about 250 feet. At each end were chains of insulators capable of withstanding as much as 3,000,000 volts.

Another problem was to prevent what are called brush discharges, in the conductors which carried the current from the net to the measuring instruments. The intensity of these discharges is less, the greater the radius of curvature of the conductor, so that the discharges would be less from a large hollow cylinder than from a smaller solid wire, with the same amount of metal. As long cylindrical conductors would have been difficult to transport to the mountain, Dr. Brasch and his associates made use of a string of short, round-ended cylinders.

From a lightning-proof metal house the observations and measurements were made. The spark gap, under the last of the short cylinders, could be regulated from this post, and, from the length of the gap across which the spark would jump, the voltage was determined.

As the chief electrical storms of the neighborhood are in the summer, and as the apparatus was not completed until last August, the best storms had to go unused. One storm occurred after it was completed, and indicated the success of the method. The spark gap could not be made larger than about 15 feet, but the sparks easily jumped across it at the rate of about one per second and continued for thirty minutes at a time. Also, it was found with an auxiliary collecting antenna, and with distant storms that affected the main station, that a discharge of once a second was possible at all times.

During the winter months, the experiments were discontinued, but the apparatus was left in place. The scientists are now preparing to return, to take full advantage of the storms this season. With the antenna about three hundred feet above the earth, a height that could easily be obtained, voltages as high as thirty million would result.

Dr. Brasch and his colleagues credit Benjamin Franklin with being the pioneer experimenter in the field in which they are working. One possible use of these huge voltages, they say, is to generate extremely rapid cathode rays, similar to those formed in the tube recently developed by Dr. W. D. Coolidge, of the General Electric Company. These are similar to one of the principal radiations from radium, but with 30 million volts, the artificial rays would travel even faster than those emanating from radium itself.

AN ECLIPSING VARIABLE STAR

THE star epsilon Aurigae in the constellation of the Charioteer, near the bright Capella, which is now directly west in the evening, is now getting fainter, several months ahead of the schedule, according to a report made by Dr. Joel Stebbins, director of the Washburn Observatory of the University of Wisconsin.

Epsilon Aurigae is one of a class of stars known as eclipsing variables, that periodically change in their brilliance. They consist of two separate globes, one brighter than the other, which revolve around their common center of gravity. When the dark one comes between the brighter orb and the earth, the light is diminished.

When at its brightest, epsilon Aurigae is of the 3.4 magnitude, but when eclipsed diminishes to magnitude 4.1. With the naked eye, on a dark night, stars down to about the sixth magnitude can be seen. The average period between the times of minimum brightness of the star in Auriga is about 9,900 days, one of the longest known periods for a star that so changes in brightness.

With his colleague, Dr. C. M. Huffer, Dr. Stebbins has been studying the changes in brightness of various stars with the photoelectric cell. This device converts the faint light from the star into a minute electric current, which can then be measured with a delicate galvanometer.

Not until later in the year was epsilon Aurigae expected to begin to diminish in brightness. Observations made on four nights since January 22 by Dr. Stebbins and Dr. Huffer show that in that time the star's light has decreased more than a tenth of a magnitude, so that it is now changing at the rate of about eight hundredths of a magnitude per month.

Just what might cause this unexpected change in brightness is uncertain, but Dr. Stebbins expects to continue observing the star in the hope of learning more about its queer behavior.

PROTECTION FROM LIGHTNING BY TALL BUILDINGS

TALL buildings and lightning rods mounted on high towers protect neighboring structures from lightning, pro-

vided they are not so high as to extend out of the cone of protection. This protected area extends around the base of the high building for a distance of between two and four times its height. Imaginary lines drawn from the top of the building to the edge of the protected area define the protected cone, says F. W. Peek, Jr., in charge of the General Electric Company's high voltage investigations at its laboratory at Pittsfield, Mass.

Mr. Peek's investigations have been made with artificial lightning at pressures of as high as three and a half million volts. These man-made flashes have been used on small models of buildings. However, confirmation of his discoveries was obtained by studying a natural electrical storm that occurred in New York last summer, and during which the New York World building was struck. Though this building is close to the Woolworth Tower, and is in the 1,100 foot circle around its base that is protected, the dome of the World building extends for about a hundred feet outside the cone, and that is the reason that it was struck, explains Mr. Peek. If it had been 200 feet closer to the Woolworth building, it would have been protected.

Practical application of these experiments, says Mr. Peek, has already been made in California, in safeguarding oil storage tanks from lightning. Several tall rods, placed outside the big reservoirs, provide overlapping cones of protection and reduce the danger to a minimum.

HOW TO LIGHT PAINTINGS

PHYSICS has come to the aid of the artist in showing how paintings can be hung to best advantage in picture galleries.

If pictures are to be seen as the artist meant them to be seen, according to Dr. J. W. T. Walsh, of the National Physical Laboratory, the lighting should be as much like unaltered daylight as possible. In cases where natural lighting is used, the windows through which the light passes, and the glass in front of the pictures should be practically colorless. Also the decorations of the roof and walls should be neutral in tone, especially where they are liable to receive direct sunlight.

One of the practical difficulties in the arrangement of old paintings is that the old paints may tend to fade. Ultra-violet light is now thought to be to some extent responsible for this condition, and to prevent it one should allow nc direct sunlight to shine on the pictures.

Another great difficulty often encountered in picture galleries is the reflection of spectators in the picture glass, or a reflection of the pictures on the opposite wall. The former type of reflection can be avoided by having a roof design in which the windows are so arranged that no direct light falls on visitors, although the pictures receive full illumination. Reflections of pictures opposite are of course best prevented by not having any pictures on the opposite wall, and some modern galleries are designed with pictures on one wall only. If this is impossible, reflections can be avoided by erecting a screen the whole length of the room.

THE OXYGEN-CARRIER OF THE BLOOD

AN important step toward the understanding of how the process of breathing sustains life has been made by Professor Otto Warburg who, in an address before the Kaiser Wilhelm Association for the Advancement of Science at Berlin, demonstrated the constitution and action of the ferment in the blood which controls the conveyance of the oxygen of the air from the lungs to the muscles. So minute an amount of this ferment or catalyst is present in the blood that it can not be isolated, yet it is an essential factor in the supply of vital energy to all animals. Its chief constituent is haemin, a chemical compound which has been known for the last seventy-five years, but which was first made artificially in the laboratory a few months ago by Professor Hans Fischer. It contains iron and is a component of the familiar red coloring matter of the blood, haemoglobin.

But the ferment is ten thousand times more sensitive to light than haemoglobin. The color of the light makes more difference than its intensity. Rays of a certain frequency will be absorbed while light of another wavelength will not affect it. These iron-containing compounds of the blood are tuned to react to select radiations like a fine radio apparatus. One of the derivative compounds can act as a sensitizer to sunshine so that a person taking a dose of it would be light-struck, perhaps fatally, by ordinary daylight, while he would be all right so long as he remained in a dark room. Pigs are sometimes so sensitized by eating buckwheat as to be sickened by sunlight.

The "breath-ferment" described by Warburg is beneficially affected by light, for when it is poisoned by combination with carbon monoxide such as may come from automobile gases, the combination is readily broken up by faint light, and the ferment can then resume its function of carrying oxygen.

GLUCOSE FOR ENCEPHALITIS

THE treatment of encephalitis by the injection of glucose has awakened considerable interest among specialists at St. Elizabeth's Hospital for the Insane. Dr. Walter Freeman, who has made many researches on encephalitis, states "that even though the way in which it works is uncertain, this mode of treatment undoubtedly offers something of importance in the treatment of nervous diseases."

The improvement of acute cases of encephalitis by glucose injections was recently announced by Dr. Leland B. Alford, of St. Louis, Mo. The action of the glucose is not well understood, but it is believed that the compound exerts a protective action on the nervous system.

The first clue to the beneficial action of glucose, according to Dr. Alford, came from its administration as nourishment to an encephalitis patient who was delirious and refused food. This took place in November, 1926. To the surprise of every one the patient began to improve. On Christmas day she recovered her senses and by New Year's day returned home and has remained well ever since. Glucose seemed the most probable factor in

this unprecedented recovery and so was given a trial in another acute case which likewise registered rapid improvement.

The method was followed up with good results in as many as forty acute cases. The injections have no harmful effects, it was stated. It has, however, brought about only slight improvement in chronic cases. The chronic form of encephalitis is particularly stubborn and to date few ways have been found of combatting it.

It will be many years, Dr. Freeman pointed out, before the glucose treatment can be properly evaluated but, he added, any method that gives hope of relief in dealing with this unfortunate disease, is worthy of trial and further research.

FAST TRAVEL IN THE ORIENT AND THE CONTROL OF DISEASE

AIR lines and bus routes in the Orient make hard work for the European health officials whose job it is to hold in check the time-honored diseases of the East.

In Iraq two new lines of communication, according to Dr. C. P. Thomson, president of the Egyptian Conseil Sanitaire, now have to be taken into consideration when cholera breaks out.

The first is the weekly airplane trip from this city to Basra by way of Palestine and Bagdad. Only 12 hours are required to reach Bagdad from Cairo, and 27 to reach Basra, since the planes do not fly by night. When this route has been extended to Karachi in western India, Dr. Thomson pointed out, a potential cholera victim from an infected center in that country could easily be on board ship at Port Said in three and a half days, before the incubation period of the disease would be completed.

The second avenue of contact is by the motor route from Bagdad to Beirut *via* Damascus, which takes only 29 hours. The traffic on this line is increasing constantly while pilgrims, always a fertile source of epidemic spreading, have already made use of it to the number of 2,000.

Medical authorities of Syria control the motor traffic while that of the airway is under strict medical surveillance by Palestine and Egypt. Travelers coming from the infected territory may be released from quarantine at the aerodrome if they can show they have received two injections of cholera vaccine, the last administered at least six days before.

During the cholera epidemic in Iraq in the summer of 1927, a supply of cholera vaccine sufficient for 700,000 doses was provided, from which about 40 per cent. of the inhabitants of infected towns were vaccinated.

ITEMS

CORONIUM, the mysterious substance in the sun's corona that only manifests itself in spectrum photographs made at the time of a total solar eclipse, is probably due to argon, third most abundant gas in the air. This is indicated in researches carried on at the Ryerson Physical Laboratory of the University of Chicago by Dr. Ira M. Freeman. "Coronium" was first found in 1869 when, in the eclipse of that year, astronomers noticed a strange line of a green color in the spectrum of the corona. This is the extremely rarefied outer layer of the sun that is visible only when the central disc of the sun is obscured by the moon. Ever since that time physicists have been trying to find the cause of it and a group of unknown lines that were later discovered. Dr. Freeman has found that 18 of these lines can be identified as those of the element argon, which occupies nearly one per cent. of the atmosphere. Other observations of the sun with the aid of the spectroscope have never shown the presence of argon, but, Dr. Freeman points out, it may well be that it is present but that it is quite possible the conditions on the sun are not just right for it to be in evidence ordinarily.

THE aid of ultra-modern chemistry has been invoked to salvage another relic of the remote past. An ancient leather roll of Egyptian writing had lain unopened for 50 years in the British Museum because it was so brittle that no one dared unroll it. Experiments with a broken fragment of the leather in the museum's laboratory, however, finally gave scientists a clue as to how to handle the mysterious manuscript. Several thin coatings of celluloid were soaked into the pores of the leather, after which it was cemented with strong celluloid on to a piece of celluloid-treated cheesecloth. In this way it was unrolled without a break and pressed flat between two glass plates to dry. It remained perfectly flat after drying and can now be read with ease.

ROMAN artisans in England only two to three centuries after the time of Christ knew how to weld iron and how to join or "solder" two pieces of iron together with copper, the Institute of Metals was told at its meeting by Professors J. Newton Friend and W. E. Thorneycroft, of the Technical College, Birmingham. The specimen examined by them was a deep iron ferrule, like a modern napkin ring, that was unearthed during excavations of the Roman city of Uriconium located on the river Severn and destroyed about A. D. 380. Lead pipe manufactured and laid in Rome's water system 1,800 years ago was pronounced to be in perfect condition by William A. Cowan, chemist of the National Lead Company, Brooklyn, N. Y., in a communication to the institute. Analysis showed that the same lead was used by the Romans in England and Italy.

THE Ruhr industrial region, recently restored to normal operation following the withdrawal of the French, has given a striking illustration of the damage wrought by factory smoke not only to trees and gardens in the cities, but to the farm crops throughout the countryside. When the French occupied the region in 1923 the Germans adopted a policy of "passive resistance," closing down all the factories. With the air cleared of its load of smoke and acid fumes, the farms of the Ruhr Valley yielded full crops for the first time in many years. Then the French withdrew and the chimneys started smoking again, and now the crops have dropped back to their previous low level.